THE
TROPICAL AGRICULTURIST

VOL. LXIV. PERADENIYA, MAY, 1925. **No. 5.**

BUD-ROT OF COCONUT.

Interest has centred around the bud-rot of coconut and other palms for several years in all palm-growing countries and a considerable amount of work upon it has been done by several mycologists. At the Imperial Botanical Conference held in London in July, 1924 this subject was fully discussed and a series of papers were read dealing with the work done in different parts of the world.

As these are of considerable interest to coconut growers in Ceylon they are reproduced in the present number of the *Tropical Agriculturist.*

Dr. Butler, the Director of the Imperial Bureau of Mycology, presented a brief summary of the present position of our knowledge of this type of disease and indicated that he was of the opinion that *Phytophthora palmivora* was the only vegetable parasitic organism which had been proved to cause the destructive bud-rot of palms and was capable of attacking perfectly healthy palms and inducing severe epidemics of disease.

In Malaya, Mr. Sharples recognises the possibilities of damage to palms by species of *Phytophthora* but states that no records of such fungi being associated with "bud-rot" in Malaya exist. Factors definitely associated with severe attacks of bud-rot in Malaya are injuries caused by Black Beetle or Red Weevil and tidal floodings in fields adjacent to rivers where sufficient protection has not been made to prevent the entry of water.

In Jamaica and other islands in the West Indies a *Phytophthora* bud-rot exists and a similar disease has been worked out in the Philippines. In the West Indies also, bud-rot has been traced to be caused to a Bacillus—probably a strain of *Bacillus coli*, but there appears to be some doubt as to whether this has definitely proved.

In Ceylon, undoubted cases of bud-rot have been found which have been caused by a species of *Phytophthora* and other cases suspected as being of bacterial origin have been examined. The mycological division of the Department of Agriculture finds that there are bud-rots of coconuts and other palms in Ceylon which are caused either by a species of *Phytophthora* or by a bacterium.

The reports which were submitted to the Imperial Botanical Conference clearly indicate that bud-rot of palms may also be due to causes other than either *Phytophthora* or a Bacillus. Swampy conditions of the soil give rise to a condition which results in a bud-rot. Drought may give rise to a similar condition, and soils unsuitable for coconut cultivation also account for this same trouble. It is also asserted by others that the planting of immature nuts may cause a kind of bud-rot.

Two mycologists at the Conference urged that the term bud-rot should be discontinued and the disease should be classified as a Palm wilt. They both drew their comparisons from the Panama disease of plantains which has been shown to be probably due to the effects of toxic substances secreted at the base of the plant.

Growers of coconuts must not therefore rush to the conclusion that cases of bud rot on their estates may be caused solely by parasitic organisms. They should rather look to the general agricultural conditions of their estates.

Good cultivation, good drainage and satisfactory manuring are likely to result in a reduced number of cases of bud-rot in palms and all growers are directed to pay attention to these matters.

With the adoption of sound agricultural methods much loss loss is experienced from pests and diseases than when faulty agricultural methods are in vogue. If a disease or a pest occurs on a coconut estate let the superintendent ask himself whether his agricultural methods are sound and upon correct lines.

Epidemics of diseases and pests are bound to occur from time to time and will then have to receive special treatment, but it is becoming more and more recognised throughout the whole world that correct agricultural methods result in smaller losses from pests and diseases. Let us recognise that in the majority of cases where pests and diseases cause considerable trouble our agricultural methods may be faulty. Material progress in the cause of agriculture will then have been made.

COCONUTS.

VARIATION IN COCONUTS WITH PARTICULAR REFERENCE TO FRUIT PRODUCTION.

The following is a summary of the article on "Variation in Coconuts with Particular Reference to Fruit Production" by H. W. Jack, appearing in the Malayan Agricultural Journal, Vol. XIII. No. 2.

The selection of seed nuts is probably of greater importance in the case of coconuts than any other crop grown on plantation lines when due consideration is given to the length of the profitable life of the palms which under good conditions should exceed fifty years.

The term "selected" as regards seed coconuts is misapplied to a very large extent as the methods of selecting them being far from scientific. The commonest method of selection is that of purchasing seed nuts from a well established estate known to produce a fair quantity of copra per acre. This method is tolerably sound in the absence of reliable tree data. A vast improvement on this method is that of examining and marking as parents the individual trees which show desirable characters. This method, if thoroughly performed, should result in a more uniform plantation than the more casual method. Trees which appear very much alike differ not only constitutionally, but seedlings from the same parent tree may be found to vary on account of cross-pollination.

For practical guidance in the matter of selecting parent trees the planter could not do better than study the lines indicated by Sampson in his book on "The Coconut." He maintains that a detailed cropping register of each tree is the ideal. A practical method for establishing a register of this nature is described in the *Malayan Agricultural Journal*, Vol. X. No. 5, 1922. This paper is based on the results obtained by the maintenance of systematic records extending over four years.

In coconut cultivation variation occurs in many characters such as colour, size and shape of fruit. Other characters such as seasonal variation in cropping, variation in root formation, variation in female flower production, and in the production of mature fruits per palm, variation in size and shape of nut, in thickness of meat, in oil content of the meat, etc. can only be revealed by careful investigations covering over an extended period.

The annual exports of copra published in the Report of the Commissioner, Trade and Customs, from the Federated Malay States reveal a seasonal variation of 12% of cropping.

Coconut palms are not periodic as regards their annual production of fruits. Climate, cultural operations and environment are the chief causes for the variation in yields of coconuts.

For the individual palm, variation in fruit production, under ordinary cultural conditions, must be largely climatic because good and poor fruiting years for a mixed population argue against the tendency in the individual

tree towards periodic fruiting. Annual variation in crops shows that fruiting has been determined by some extraneous circumstances which affect all the trees in a plantation alike, whereas if there was any innate tendency towards periodic fruiting it would be exhibited by different individuals in the same year, and consequently, in a plantation containing many palms, annual uniformity of production would result. This paper shows that uniform annual production is not achieved under normal conditions.

Sampson recorded wide variations in the number of roots formed per palm on palms growing under the same conditions. Six palms of the same age, growing in the same field, showed a range of variation in the number of roots per palm from 1,460 to 2,405.

Similarly, variations in female flower production amongst palms of the same age have been recorded by the same author. These he attributed as due to physiological and climatic changes. For instance, the number of female flowers per spathe on consecutive spathes of a single typical tree covering a two-year period were found to vary from 9—50 with an average of 18.

In a mixed plantation of 102 palms approximately 10 years old, growing on excellent coastal land, the number of spathes, in situ per palm was found to vary from 2 to 18 with an average of 9, all the palms receiving as nearly as possible the same treatment in cultivation and drainage.

Within the same variety, under the same conditions of climate and cultivation, enormous variation in the size of the kernel is found ranging from 0·4 to 0·6 of an inch as average limits. With heavy and exhaustive cover crops like sweet potato or tapioca the meat is frequently much thinner being less than 0·2 inch.

The oil content of the meat has also been found to vary between 52 to 80 per cent. Preliminary experiments show a variation in the oil content of nuts grown on the same tree of 11 per cent.

There is also a wide variation in the amount of (toddy) obtainable from the treated flower stalks of different palms. The flow is affected with the change of climate.

Young palms do not yield such a rich juice as older ones, and the tips of the spathes produce sap which is not so rich as the sap produced by the middle or lower parts of the spathe.

There exists a variation in the rate of germination of nuts of the same variety. In this instance, naturally, a certain proportion of the variation was due to differences in ripeness of the nuts.

Variations in the shape, size and weight of fruits and of kernels, etc. due to varying environmental conditions, and as such these variations are found to fluctuate about the "mean" or "mode" for each character provided that observations are maintained for a sufficiently long period, that fair cultivation is maintained and that the trees are not too old. On the other hand, each tree will retain its own individuality as long as conditions favour a fair degree of development.

In confirmation of this statement, it has been found that in mixed populations good producing trees on the average remain proportionately good yielders from year to year, while poor yielders continue to produce poorly.

These records do not cover a sufficiently long period to render the figures absolutely reliable but their comparative uniformity would definitely indicate that the ability to fruit, apart from seasonal variation, is an hereditary character.

A summary of records on which this study of variation in fruit production is based is given as an Appendix. The fruit was collected 39 times, or once every five weeks between 1-6-1920 and 31-5-1924, a period of four full years from a local coconut estate (Jugra Lands and Carey United, Division 1) of fair average productive capacity as may be gauged from the following figures of copra production per acre per annum from the field in which the records were compiled (the full year ended in April in each year):

Year		Piculs.
1915	...	3·21
1916	...	7·31
1917	...	8·88
1918	...	9·77
1919	...	11·74
1920	...	14·46
1921	...	13·35
1922	...	9·30
1923	...	12·97

A block of 480 trees growing in 20 rows was selected for experiments. Average age of the trees was just under 10 years; the trees were planted 30 by 30 feet apart.

The soil consists of stiff alluvial clay loam uniform in texture and the estate was well drained. Estate was first clean weeded; but later on a cover crop of *Centrosema Plumieri* was sown.

The rainfall during the four years was 95·89 inches per annum. Of the 480 trees 5 palms have not commenced bearing, therefore, the records were collected from a typical population of 475 palms growing under same conditions.

After 4 years' records, calculations showed a mean of 6 nuts per palm and a range of variation of from 1 - 12 nuts. Pickings occurred every 5 weeks. In 80 per cent. of the pickings nuts were only cut from a single spathe. The greatest number picked from tree No. 5 of row No. 6 gave up to 30 nuts with an average per picking over the 4 years of 11 nuts. Highest average picked was 12. Some trees failed to give any nuts. Majority of these had a habit of close branching. This upward branching apparently correlated with poor yield. These trees never produced any crop that could be classed as better than poor.

The following table shows the yields per annum of the twenty-four palms to which reference has been made, together with notes of habit or other cause of poor yield. The first six trees in the table were favourably situated besides drains.

Row No.	Tree No.	No. of times no fruits were obtained	Yield of fruits in 1920	Average yield per annum over 4 years	Notes on Habits, &c.
1	13	4	3	20	Nut-fall
10	1	3	3	17	Up-branching
10	14	4	1	18	Over-Shaded
10	20	11	9	18	,,
11	5	3	7	20	,,
20	1	6	10	29	Up-branching
2	3	3	10	22	,,
2	5	3	7	20	,,
2	11	5	8	13	,,
3	2	2	9	36	,,
3	9	8	9	17	,,
3	11	11	10	13	,,
3	16	8	0	20	,,
4	23	22	1	5	Deformed
5	15	16	4	8	Up-branching
5	19	14	0	7	,,
6	15	16	1	6	,,
6	16	2	6	27	,,
8	24	13	0	6	,,
9	16	3	6	26	Bent & Shaded
9	17	2	8	37	Up-branching
13	14	3	8	24	,,
14	4	16	4	13	,,
18	16	13	4	9	,,
24 trees		191	—	431	—

Mean yield per annum per palm $= \frac{431}{24} = 17{\cdot}96$—say 18 fruits.

VARIATION IN RATE OF REACHING MATURITY.

On flat alluvial land in this country, it is commonly noticed that young palms, usually about 10 years old, which have been yielding fairly well for 2-3 years, sustain a set-back and produce poorly for 1-2 years before again yielding good crops. This habit is possibly an environmenta ffect resulting

from a high water table which probably arrests the development of the natural root system temporarily, causing a shock which retards growth for a time. The habit is, however, also recorded on estates which maintain a fairly low water table (four feet or more) so that it may be merely a growth character, marking the period, after which palms may be said to be mature.

VARIATION IN COPRA PER NUT.

Experiments are in operation on this question. The present data are not sufficient. Records from seventeen trees show a range of variation of 211-270 grammes in the average weight of copra per nut.

CONCLUSION.

The existence of variation in several characters of the coconut palm has long been recognised, but definite statistical proof of the degree of variation has been very scant. This paper shows definitely that there is a wide range of variation in fruit production per palm. The disposition of the palms from which the records were collected would indicate that the variation was not due to varying soil conditions, for good and poor producing palms stand side by side with great frequency; moreover, alluvial clay soils are notable locally for their general uniformity. Variation in other characters is also indicated.

The frequency curves show the variation in production graphically, and their inspection demonstrates the need for selection in this important branch of tropical agriculture, although results can only be obtained after many years of patient work.

BUD-ROT OF COCONUT AND OTHER PALMS.

The following papers on "Bud-rot of Coconut and Other Palms" are taken from the Report of Proceedings of the Imperial Botanical Conference held in London in July, 1924.

DR. E. J. BUTLER, C.I.E.

A disease of palms, which was stated to have many points of similarity to that known as bud-rot in the West Indies, was described by the writer in 1906 and attributed by him to a species of *Pythium*, which was subsequently, in February, 1907, named *P. Palmivorum* n.sp. This was the first *named* cause of bud-rot which subsequent work has substantiated. The species is one of those forming a connecting link between the genera *Pythium* and *Phytophthora*, and in 1919, when knowledge of the latter genus had considerably advanced, the palm fungus was renamed by the writer *Phytophthora palmivora*.

In the West Indies the bud-rot of coconut palms seems to have been known for about a century, and was ascribed to various causes such as insects, bacteria, soil, and climate. Davalos believed that *Bacillus amylobacter*, which he isolated from the rotted tissues in 1886, was the cause in Cuba. Fawcett attributed it to "an organised ferment" in Jamaica in 1894. Earle also, in 1902, believed it to be a bacterial disease. In 1904 Dr. E. F. Smith definitely stated, as a result of his investigations on the spot, that the

disease in Cuba was a bacterial soft-rot of the terminal bud and its wrappings, the causal organism probably entering through wounds, though no experimental evidence of these statements was given. Petch stated, in 1906, that bud-rot in Ceylon was due to bacteria. Smith induced his assistant, J. R. Johnston, to undertake the detailed study of the disease, and the results of four years' work in Cuba and elsewhere were published by Johnston in 1912. Succesful inoculations were claimed with several varieties of bacteria. Only a few of these inoculations were done on the spot, the rest being on seedling coconuts under glass in Washington. The greater number of the inoculations were made with *Bacillus coli* or an organism indistinguishable from it, while *B. coli* from animals was found capable of setting up a soft-rot similar to that caused by the strains from coconut, when inoculated on green-house seedlings. A preliminary account of these inoculations was published in *Phytopathology* in 1911. It may be mentioned, in passing, that the isolations were made by the poured plate method, which would be unlikely to reveal the presence of such a fungus as *Phytophthora*, and that the bulk of the inoculations were made with a gouge or some such instrument penetrating at least 30 cm. into the bud. But in 1911 Rorer agreed with Johnston's findings and stated that pure cultures of a bacillus (which he isolated but did not identify) could cause bud-rot if poured into the crown without wounding.

In 1914 Shaw and Sundararaman published certain criticisms of Johnston's work and produced detailed evidence, founded on inoculations from pure cultures, that *Pythium palmivorum* (*Phytophthora palmivora*) caused coconut bud-rot in India. Further inoculation experiments, to meet objections raised by Sharples and Lambourne in Malaya, have been carried out by McRae and by Sundararaman in India, with the result that the earlier work was again confirmed. There is now not the slightest doubt that the epidemic outbreak of bud-rot in palms on the east coast of India was due to this fungus and only to this fungus, which is a true parasite capable of penetrating the uninjured tissues almost as readily as *P. infestans* does those of the potato.

In 1918 Ashby stated that there were two forms of bud-rot in Jamaica, one of which was due to the same *Phytophthora* as he had earlier found causing a leaf disease of coconuts. In 1920 this was identified as *Phytophthora palmivora*, the cause of the disease in India, and proof of its ability to penetrate the unwounded tissues was given. In the second type of bud-rot only bacteria were found, but some doubt is expressed as to their causal connection with the disease. In 1923, however, Nowell was still of opinion that after excluding the forms of bud-rot due to fungi there may still remain a large residue of bud-rot of bacterial origin in the West Indies.

In the Philippine Islands the study of coconut bud-rot was taken up by Reinking who, in 1918, believed it to be a bacterial disease. This view he soon abandoned and, in 1919, he stated that a *Phytophthora*, which he identified as *P. Faberi*, was the cause, the bacteria which are always present in severe cases being secondary agents. In 1923 further studies were published by Reinking which seem to leave no room for doubt that this fungus is a true parasite and is capable of infecting uninjured coconut palms, whether the organism is isolated from coconut or from cacao (the original host of *P. Faberi*).

This at once raises the question whether *P. Faberi* is distinct from the earlier described *P. palmivora*. Reinking answers in the affirmative, but his argument is based on a misconception. No oospores were found in the Philippine fungus, whereas he states they occur in that in India. It is true that in my 1907 paper I stated that oospores were formed, but these were subsequently found to be chlamydospores or resting conidia, of a type previously unknown in *Phytophthora* but subsequently found to be not uncommon. From a careful study of Reinking's figures and description I am of opinion that his fungus is morphologically identical with my *P. palmivora*. Thus both in the west and in the east it has been established that this fungus is at least a chief cause of bud-rot.

As to Reinking's identification of this species with *P. Faberi*, widely known as a parasite of cacao and rubber, a few words more are required. Ashby admits that *P. palmivora* and *P. Faberi* are morphologically indistinguishable but, unlike Reinking, he finds biological differences. In his last paper on the subject, in 1922, he reports the discovery of oospores in mixed cultures of the cacao fungus with other morphologically similar strains from coconut and cotton and also with the distinct species *P. parasitica*. In view of the biological differences and the absence of oospores from all but the cacao strain he maintains *P. Faberi* and *P. palmivora* as distinct species. But it is clear from Reinking's work that the biological differences are not preserved in the Philippines and it is equally clear that oospore-formation is rare and difficult to induce in the cacao fungus, so that I prefer to regard the two as at most strains of the one species, less highly differentiated indeed than many of the strains of the rusts and Erysiphaceae.

Whether there is any such thing as a primary bacterial bud-rot of palms seems to me to be doubtful. Most of the successful inoculations have been carried out through wounds in the tender tissues of the interior of the bud, and with such methods not one but several distinct bacteria have been found capable of setting up a soft rot. Sharples and Lambourne have indeed shown that various common moulds, such as *Mucor*, can cause such a rot in wound inoculation. The same is well known to be the case with ripe fruit and young seeds, always only after injury. I do not regard the fungus as a primary parasite in such cases, and it is at least in a very different category from the parasitism of such organisms as *Phytophthora infestans* or *P. palmivora*. *P. palmivora* remains the only vegetable parasite that has been proved to cause a destructive bud-rot of palms, capable of attacking perfectly healthy trees and inducing severe epidemics of disease.

(A short account of the campaign against bud-rot of palms on the east cost of India was then given.)

OBSERVATIONS ON BUD-ROT OF PALMS.

MR. A. SHARPLES.

The world-wide distribution of *Cocos nucifera* and its economic importance ensure interest in the pathological disturbances commonly met with in plantations. An epidemic disease in this important crop demands serious attention, and considerable time and energy over many years has been devoted

to the question of the unmistakable rotting of the cabbage or bud, owing to the intrusion of various organisms causing decay, which in its most severe form results in the death of large numbers of trees wherever coconut plantations exist. At the present time, the usual conception of "bud-rot" takes the form of the possibility of large losses owing to epidemics caused by fungi belonging to the genus *Phytophthora*. Recently, a more reasoned statement has been issued respecting a more general conception.

"BUD ROT" IN THE WEST INDIES.

Nowell, in his recently published book entitled *Diseases of Crop Plants in the Lesser Antilles* devotes considerable space to this subject and his observations are of much importance. His observations parallel those of the writer in Malaya, but as "bud-rot," associated with various *Phytophthora*, *spp.* appears a well-marked feature in the West Indies, this author adopts a cautious attitude. In Malaya, the writer has seen much "bud-rot" both in coconut and African oil-palms, which might have been considered epidemic and therefore caused by a species of *Phytophthora*, but in all cases a consideration of other factors suggested a more probable explanation, and the possibility that further spread of the disease need not be anticipated.

A few extracts from Nowell's book under the heading of "Bud-rot in General" might be given here:

Nematode infestation has been recently found to be responsible for a large amount of so-called "bud-rot" occurring in British Honduras and may be expected with confidence to account for a good deal more elsewhere. The writer (Nowell) has found that typical "bud-rot" of this kind, indistinguishable in appearance from the infectious forms, follows rapidly on the death of healthy trees from poisoning or severance of the stem. The fact is, that a characteristic stinking rot, dominated by bacterial putrefaction, forms the natural process of decay of the large amount of tender tissues, deeply enclosed by the successive sheathing bases of the leaves .... It is now becoming apparent that the true infectious "bud-rot" existing in the West Indies is of more than one kind.

"BUD-ROT" IN MALAYA.

The writer was brought into contact with the "bud-rot" problem owing to an attempt made to establish plantations of African oil-palms (*Elaeis Guinensis*) in Malaya during the last few years. These palms appear to suffer more severly from "bud-rot" than coconut palms. Young oil-palms, 2-3 years old, show a 10% infection of a disease of the central leaves, the earlier stages of which might well be considered an incipient form of "bud-rot," while the older palms show numerous cases of typical "bud-rot."

The symptoms on the young oil-palms are well marked; the third or fourth leaf from the centre of the crown is attacked towards the base and the leaf tissue at this spot becomes water-logged, soft and transparent looking, the leaf quickly falling over. The outer leaves, in succession, are attacked and fall over. The appearance is then a series of collapsed outer leaves, with the light-green, tender looking young central leaves standing erect in the middle. In all cases, recovery of the young palms has been complete, the central meristematic parts of the bud remaining untouched. This feature is of interest, for the lines followed in nature practically parallel those demonstrated by inoculation experiments with *Phytophthora sp.*, *i. e.* that rotting of the bud does not necessarily follow even a severe infection of the young, tender heart-leaves.

Little information could be found in the literature of palm diseases to help in the interpretation of the symptoms observed in the young oil-palms, but the writer's experience of coconut "bud-rot" led to the inception of experiments to test the significance of conclusions based on "stab inoculations" in the various researches published. Much importance has been assigned to the success of "stab inoculations" practically in all published works on "bud-rot" of palms, chiefly owing to the difficulty of obtaining definite results by other methods. The results of the experiments proved beyond doubt that numerous widely separated organisms, other than members of the genus *Phytophthora*, were capable of producing typical "bud-rot" symptoms when stab-inoculated directly into the cabbage or bud. The results provide strong indications that only carefully controlled inoculations conducted without injury to the bud could be of significance in interpreting experiments towards elucidating the true value of any organism as the causal agent in "bud-rot."

PHYTOPHTHORA SPP. ASSOCIATED WITH "BUD-ROT" OF PALMS.

Phytophthora omnivora var. *Arecae* has been shown to be associated with a disease of the crown of the areca palm (*Areca catechu*), though principally a nut disease, in India.

Phytophthora palmivora (Butler)=*Pythium palmivorum* (Butler) has been connected with "bud-rot" of palmyra palms (*Borassus flabillifera*) in India. Successful experimental inoculations of the young tender heart-leaves were recorded. The same fungus was shown by Shaw and Sundararaman to be associated with coconut "bud rot" in India. Similar inoculation results to Butler's were recorded, but under conditions of extreme humidity, the falling over of the central leaves was brought about in a seedling plant grown under a bell-jar.

Phytophthora Faberi has been associated with coconut "bud-rot" in the Philippines by Prof. Reinking. His conclusions were based largely on stab inoculations.

Phytophthora palmivora has been shown to be associated with coconut "bud-rot in the West Indies. Similar inoculation results to those obtained in India were recorded. Ashby specifically remarks that his artificially inoculated plants were not affected in the heart tissues.

Phytophthora parasitica has been shown to attack coconut palms in the West Indies but has not been associated with "bud-rot."

FACTORS ASSOCIATED WITH "BUD-ROT" IN MALAYA.

There are no records of *Phytophthora sp.* being associated with "bud-rot" in Malaya. Among planters, this disease naturally attracts attention in its later stages even if only a single tree is killed, without any sign of attack on neighbouring trees. As with *Hemileia vastatrix*, the cause of the Coffee Blight in Ceylon, it serves as a standard instance of the ravages caused by epidemics of plant disease.

Factors definitely associated with severe attacks of "bud-rot" of coconut palms in Malaya are: (*a*) injury caused by attacks of Black Beetle (*Oryctes Rhinoceros*): (*b*) entry of Red-stripe Weevil *Rhynchophorus Schach*) into the presumably previously injured portions of the cabbage; (*c*) tidal floodings in fields adjacent to rivers where sufficient protection has not been given to prevent the entry of water.

The above factors could not be confused with those which would have suggested epidemic "bud-rot" caused by a *Phytophthora sp.*, but further field investigations have brought to light factors which lead the writer to emphasise the quotations from Nowell's book given above. A disease of coconuts has been under observation in Malaya over the last two years which parallels the red-ring disease caused by nematode infection and described by Nowell. The symptoms in the last stages of decay of the crown are typical of "bud-rot" and the disease has been reported as such from all parts of the country where coconuts are grown. In a few cases, it was noticed that the central leaves were the last to collapse, a feature directly opposed to the usual "but-rot" symptoms, in which the central leaves collapse before the outer leaves. Careful cutting of the whole length of the stem of such cases shows the base of the stem with the internal tissues discoloured, a beautiful salmon-pink with patches of yellowish discoloured tissue. The bud is quite healthy in these specimens. Apart from a narrow external ring of healthy tissue, the whole stem in transverse section is discoloured. In Nowell's red-ring, the discoloured tissue forms a circular zone enclosing healthy tissue. The absence of nematodes has been carefully checked and no sign of nematode infection has been observed. The discoloured tissue is found passing to varying heights in the stem but usually there is some healthy stem tissue intervening between the upper limit of discoloration and the crown, even when the whole of the leaves have collapsed and the bud completely rotted.

The facts suggest a gradual cutting down of the water supplies, owing to the entry of an organism through the roots which gradually passes up the stem. The symptoms have been well established in a severe outbreak, in which every tree in a two acre block of 22-years old trees had to be cut out. Little has been done beyond field observations, but anatomical examinations of diseased tissue show a frequent occurrence of a coccus bacillus, while cells filled with packets of spores, suggesting algae rather than fungi, are fairly common. The symptoms described are invariably labelled "bud-rot" by the planter and until the occasional standing of the central leaves with healthy bud tissue had been observed, it would be difficult to contradict the suggestion.

Recently another variation of the above was discovered. The writer had successfully demonstrated the symptoms associated with the disease described above to a group of planters, when, walking from the main infection, a typical case of the erect central leaves with collapsed outer leaves was observed. The tree was cut down but there was no sign of discoloured tissue at the base of the stem. This was split from the base to the crown and for about 12 feet upwards the stem tissue was perfectly sound. About this height a typical bacterial soft-rot of the stem tissues became apparent and continued for 8 to 10 feet to within 9 inches of the crown; at this point there was a sharp line of demarcation between diseased and healthy tissue, and the stem tissue below the bud was still healthy. The bud showed no signs of attack. There is little doubt that if this case had not been examined until a few days later the bud would have been involved, and the verdict would have been typical "bud-rot," the organism passing downwards from the diseased bud into the stem. Bacteria were present in the affected tissues in enormous

numbers, but proved difficult to culture. Morphological work shows a rod-like bacterium present in the cells of the ground tissue and in the intercellular spaces in large numbers, while there is no suggestion of fungus mycelium.

The facts elicited, coupled with Nowell's work in the West Indies afforded strong reasons for a change of policy respecting the drastic treatment of cutting out and burning all palms suffering, or suspected to be suffering, from "bud-rot." Coconut palms are difficult to treat because of their height, but African oil-palms can be got at more easily by cutting away some of the outer leaves. A group of mature oil-palms was cut out after being badly attacked and replaced in the centre of the rows of healthy palms. Treatment consisted in scraping out all the diseased bud tissue as completely as possible followed by placing a few handfuls of salt in the cavity. Oil-palms readily re-root in presence of plentiful supplies of water, but the crux of the matter was whether new leaves would appear: presumably the whole of the meristematic tissue comprised in the bud had been destroyed owing to the attack and it is usually taken for granted that with the death of the bud, no more leaves can be produced. However, in every case new leaves were produced and the palms recovered, a feature observed in many cases in the coconut palms artificially infected in the experiments mentioned above, though oil-palms recover comparatively rapidly. This method of treatment of oil-palms has been carried on since, and only one case, out of many dozens, has succumbed, the rot travelling down and completely killing the stem.

From the applied stand point, it appears to the writer that too much stress is placed upon the epidemic form of "bud-rot" associated with *Phytophthora spp.*, though during the last two or three years there has been more attention directed towards inoculation experiments conducted without injury to the bud. It is doubtful if a sharp distinction can be drawn between epidemic "bud-rot" associated with *Phytophthora spp.*, and "bud-rot" due to other causes, for it is easy to imagine that with some appropriate change of conditions, the latter might cause much damage over large areas, instead of occurring sporadically as at present. Each addition to the list of agencies which cause symptoms simulating those described for epidemic "bud-rot" tends towards a decrease in confidence in the belief that a definite cause, or a cause which should have superior claims over others, has been established. Until exhaustive inoculation experiments without injury to the bud have been successfully carried out to prove undoubted rotting of the bud tissues, there appears little reason why we should accept the position usually taken up in connection with this problem. Much of the significance for the present attitude might be discounted did the fungi connected with the problem belong to a genus other than that of *Phytophthora*, but knowing the potentialities of the members of this genus, it is "playing safe" to exaggerate the possible effects, in the absence of exact knowledge. The writer is of the opinion that it would be advisable to consider rotting of the bud as a purely secondary phenomenon, following on attacks from widely different organisms, or resulting from changes in physiological conditions, small in themselves but which may release large potentialities. The acceptance of this view would lead to a careful

investigation of points which might be otherwise neglected and which might be of much significance in a correct understanding of the present complicated position, besides being of much importance in the future development of industries dependent on successful palm cultivation.

Careful comparative inoculation experiments with *Phytophthora Faberi* obtained from Prof. Reinking and *Phytophthora palmivora* obtained from Dr. Butler have been carried out in Malaya, but no positive results have been obtained.

BUD-ROT OF THE COCONUT PALM IN THE WEST INDIES.

PROF. S. F. ASHBY.

In a number of palms all the leaf-stalks pass downward into thin closed sheaths forming together a rigid cylindrical column several feet long. This is the case in the palmyra and the West Indian royal and cabbage palms (*Oreodoxa regia* and *O. oleracea*). In the coconut palm the column is confined to a restricted number of leaf-stalks in the centre of the crown, the closed sheathing portion being a thin fibrous lateral extension of the stout stalks above their enlarged bases. As the fibrous sheath or strainer ruptures the leaf-stalks bend away from the vertical and cease to be in close contact. Low down in the middle of the central column or central shoot is the bud consisting of the massive meristematic tender tissue at the apex of the stem surmounted by the primordial leaves and known commonly as the cabbage. In the West Indies the term "bud-rot" is taken to mean a rot of the tender non fibrous tissue at the apex of the stem; the growing-point being destroyed, further growth ceases and the tree dies. In order that the well-protected bud may be reached by a parasite it must either penetrate the central shoot laterally through the enveloping leaf-stalks or vertically downward by way of the folded central leaves or work upwards through the fibrous tissue of the stem. A specific primary bud-rot cannot therefore be recognised and it would appear equally justifiable to describe red-ring as bud-rot as the so-called bacterial disease in both of which marked symptoms are present in the outer crown before the bud is destroyed. From the stand-point of field observation the nearest approach to a specific bud-rot may be seen in the *Phytophthora* rot present in Jamaica and undoubtedly elsewhere in the West Indian region. Usually the first symptom noticed is the dead broken end of the youngest visible leaf; this leaf can be drawn out and shows a soft malodorous rot where the stalk has ruptured. If the tree is cut down and the central shoot split longitudinally, the bud will be found fully destroyed forming a pasty or semi-liquid mass. As a rule even when the youngest leaf or leaves are wilting and turning pale the bud will be found fully soft-rotted. On a few occasions, however, the bud has been found in a wilted but not disintegrated condition, its tissue being fully invaded by the mycelium of a *Phytophthora* with a soft-rot beginning at a few points on the surface.

In most instances where the bud was already fully soft-rotted spots were present going through the thick and thin parts of the successive leaf-stalks in the central shoot: the internal tissue of the spots was penetrated by a

Phytophthora and felts of its mycelium were frequently developed on their faces; it was isolated (1) from the internal tissues and got into pure culture. Less frequently infection occurred also on the folded leaves within the shoot, resulting in the appearance of rows of spots on the pinnæ when the leaves unfolded; the same fungus was isolated from webs on the inner faces of these spots. Observation showed that during the rainy season this symptom of leaf-spotting was often followed by bud rot. In some instances the spots ceased to appear and the trees showed no further effects; this was the case when zoospore suspensions from pure cultures were poured into the hearts of young vigorous trees about four years of age; three or four successive leaves emerging from the shoot showed rows of spots, but later leaves were free from them and the trees were still healthy a year later. An inoculation experiment showed that mycelium from pure culture could penetrate an uninjured young leaf-stalk, and when a zoospore suspension (2) was introduced into the shoot of a seedling the bud was found rotted by the fungus at the end of a month.

The disease appears to be endemic in Jamaica in districts where there are considerable areas in coconuts, as most large plantations lose a few trees from it every year: during periods when rainfall exceeds the average, cases increase. In situations subject to flooding and difficult to drain, protracted rains have been followed after an interval of one to two months by serious losses in trees from two to twenty years of age. It is not believed that *Phytophthora* bud-rot is restricted in the West Indies to Jamaica; a mycelium of similar character has been found in tissues of specimens from cases of bud-rot in St. Lucia, the Virgin Islands and Trinidad, and a *Phytophthora* has been isolated recently from bud-rot in Porto Rico. Reinking's (3) observations in the Philippines show how easily the fungus infection can be masked by secondary bacterial soft-rot, in producing which species closely related to or identical with *B. coli* appear to be active.

The symptoms of this bud-rot in Jamaica are in agreement with the *Phytophthora* disease of coconuts in India (4, 5) and the Philippines (3) and the fungus seems to be the same species. Although the *Phytophthora* of pod-rot and canker of cacao in the West Indies appears to be the same species as that on the coconut, it is not believed to be the same strain, as the form from the palm has not been found able to rot cacao pods, and oospores (6) hitherto have been developed only by the strain from cacao.

Some years ago a disease showing different initial symptoms but terminating in a soft-rot of the bud received much attention in Cuba. The first indication was the shedding of young nuts followed by dark discoloration of successive flower-spikes as they emerged from the swords. The outer leaves turned yellow, died back and gave way at the base; finally the youngest visible leaves withered and growth ceased. Examination showed a wet rot near the bases of the opened and unopened swords, a decay at the bases of the leaves, a wet rot of the leaf-stalks in the central shoot and a soft-rot of the bud.

The succession of symptoms was seen mostly in large trees with trunks up to 60-80 ft. in length; in younger trees the failure of the heart-leaf was usually the first visible symptom. In the Baracoa district, a coastal strip about 30 miles long in North East Cuba, the losses were especially heavy

during a period of about ten years. In 1912, J. R. Johnston (7) recorded his observations based mainly on four years' study of the disease in this district, but also on visits to other parts of the West Indies. He found *B. coli* and related bacteria regularly in the rotted tissues and succeeded in setting up a soft-rot by boring holes through the central shoot into the bud or adjacent leaf-stalks and injecting suspensions of pure cultures, anticipating Reinking's similar methods with similar bacteria on the bud-rot in the Philippines, which he recognised later to be due in the first instance to a *Phytophthora*.* After 1912 the author in Jamaica saw large trees dying off with symptoms like those of the Cuban bud-rot. There were occasional cases in the same spots where trees had been recorded as dying ten years earlier. They could be interpreted as cases of premature senescence under unfavourable external conditions. Coconut palms are now known to die off with quite similar symptoms in red-ring disease, trunk rot, one or more ill-defined root troubles and severe drought.

It is difficult to estimate the significance of the external factors in the Cuban disease as Johnston's report is very bare of ecological data and his tendency to regard any condition of disease terminating in a soft-rot of the bud as due to a specific bacterium increases the difficulty. Some plantations in the affected district, stated to be well cared for, were practically free from the disease, but the usual condition was one of neglect. According to Horne (8) the disease progressed during a long period of severe drought which killed off numbers of the resistant royal palms.

The etiology of this disease must be regarded as still obscure; if a specific bacterial rot of the coconut palm exists it seems doubtful if the causative agent has been found. A bacterial bud-rot of canna has been described by Miss M. K. Bryan (9); the organism was able to infect uninjured rolled leaves in the shoot though the stomata and its cultural characters showed it to be unrelated to *B. coli*. Two clearly recognisable diseases of the central shoot which do not as a rule terminate in a rot of the bud, occur in the West Indies. These are the *Thielaviopsis* leaf-rot (10) and the little-leaf disease (10).

Thielaviopsis paradoxa is the cause of large wedge-shaped spots with broad dark margins which run across the folded segments of the young leaves in the shoot before they are pushed up into the light; as the leaves open out the mid-ribs of the pinnae break at the diseased places and the terminal parts wither or tear away, giving the crown a ragged appearance. The fungus is invariably present in the rotted spots and sporulates freely on and in the tissue. The disease was epidemic in Jamaica for some years on young bearing trees from 10-15 years of age in a coastal belt about 40 miles long, having a high to moderate rainfall. Natural recovery occurred, but many cases ware cured by cutting back the central shoot below the spotted region and applying a dry mixture of lime and sulphate of copper to the severed surface. The strain of *Thielavcopsis* present was the same as that causing the rot of cane cuttings, pine-apples and banana suckers; it differs from the saprophytic strain common on recently cut surfaces of coconut trees in not developing coremia. The disease has been recorded also from Porto Rico (11).

* Johnston also found *Diplodia*, *Pestalozzia* and an unnamed fungus, evidently *Thielaviopsis*, frequently present in the central shoot, and Fredholm attributed a disease with similar symptoms in Trinidad to *Diplodia*.

In little-leaf disease the central shoot sends out a succession of crumpled and distorted leaves which become progressively smaller until they are completely dwarfed; the upper surfaces of the leaf-stalks show raised brown stripes and patches which become woody and cracked. The rigidity imparted to the central shoot by these indurated leaf stalks is apparently the cause of the crumpling and, in part, of the distortion of the young leaves. It is not clear how it can be the cause of the dwarfing. Spontaneous recovery not infrequently occurs, or occasionally the bud may wither up or soft-rot. Recovery is much facilitated by slitting the strainers of the central leaves and pouring into the heart a diluted Jeyes fluid or tobacco extract. The cause of this peculiar condition is obscure. F. S. Earle, (12) who studied little-leaf in Cuba, concluded (in 1912) that it was caused by an attack of aphis (*Cerataphis latania* Bdv. Per.) on the very young leaves in the shoot. The aphis was tended by ants which probably were responsible for transporting it. The dwarfing of the leaves would on this view be a case of stigmonose; it would also account for the efficacy of contact insecticides if they are an essential part of the treatment. Little-leaf occurs in Cuba, Jamaica, Trinidad, Tobago and Grenada and doubtless in other parts of the West Indian region.

A complication in which this disease was associated with beetle attack resulting in considerable rotting of the central shoot has been observed in Grenada. Some trees which were recovering naturally showed the development of a shoot having peculiarities resembling those described by Sharples in cases of beetle attack followed by central shoot rot in Malaya(13).

In addition to the bud-rot caused by *Phytophthora palmivora*, another species(1) of that genus has been found in the crowns of coconut palms in Jamaica. In this disease infection seems to start on the thick bases of leaf-stalks commencing to separate from the central shoot. Penetration progresses slowly so that the affected leaf has reached an intermediate position between the shoot and the outer fringe of leaves before it begins to turn yellow at the tip and gradually dry up. Large spots up to 3 inches in diameter or elongated patches are present on the stalk several inches above its attachment to the stem. The *Phytophthora* can be isolated at once in pure culture from the interior of these spots as the tissue is usually free from bacteria. Several leaves may become infected apparently independently as neither sporangia nor mycelium has been found on the surface of the spots. Bunches of fruit in the axils of these leaves are liable to drop the nuts before they are full grown owing to loss of support. This attack has not been found to result in bud rot as the central shoot remains healthy. The fungus forms oospores in culture and agrees closely with *P. parasitica* Dastur. It was found also in Jamaica in a leaf-base rot of pine-apple plants, a foot and stem-rot of tobacco, and fruit rots of egg plant and tomato, and causes in the Lesser Antilles a boll-rot of cotton. It was present in leaf-stalk rot of coconut palms with trunks over 20 ft. long.

In Jamaica it has been customary for many years to cut down trees which have died or appeared to be dying with symptoms resembling those of the Cuban disease and to burn, at least, the central shoots. Since 1911 the treatment has been compulsory, and was later made to cover cases of *Phytophthora* bud-rot. In the earlier years there can be no doubt that many

trees so treated were affected by the curable *Thielaviopsis* leaf-rot and little-leaf diseases as at that time almost any symptom of disease showing up in he crown was attributed to an infectious bud-rot. The procedure seems justified in cases of *Phytophthora* bud-rot in view of the evidence as to its infectious character obtained in India and should hold good for the complete destruction by fire of red-ring cases where that disease exists. In cases where the failure is of the Cuban type the presence of an infectious disease has been assumed without good grounds and what evidence there is as to the effect of this treatment on control seems to be a negative character(14).

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SOME OBSERVATIONS ON THE BUD-ROT DISEASE OF COCONUT PALMS ON THE EAST COAST OF AFRICA.

MR. W. J. DOWSON.

This brief paper embodies some observations made and recorded during the years 1913 to 1920 in the vicinity of Mombasa on plantations of coconut palms laid out under European supervision. Many of these were examined on account of the presence of bud-rot disease, but two, in particular, were visited a considerable number of times. One of these lay

30 miles to the north of Mombasa, about half-a-mile from the sea, and the other some 30 miles to the south and about the same distance from the sea. The first contained palms mostly of local origin, but a few acres had been laid out with palms raised from nuts imported from Ceylon. The second had been planted up with local African and with Zanzibar nuts.

The cultivation of both plantations can only be described as poor, as the palms were growing in rank grass and weeds, chief of which was the doum palm (*Hyphæne thebaica*). Occasionally these were cleared and burnt as labour became available, but cultivating was hardly ever done regularly. Under such conditions palms generally commenced to bear nuts in their seventh year, and it was just at this period that the disease made its appearance with devastating results. Older palms in full bearing, in either European or native owned plantations, were not attacked so far as we know. An early and striking symptom of the disease, obvious at a distance, was the bending downwards and yellowing of the outermost (and therefore the oldest) leaves. The appearance of the rest of the foliage was normal, with the exception of the innermost unexpanded frond or spear, the exposed portion of which was dried up, brown in colour, and dead. The concealed part, covered by leaf bases, exhibited various stages of rotting.

This part was soft and not firm, slimy, and when removed emitted a most offensive odour, indicating the presence of putrefactive bacteria. No spotting was observed on the leaf bases such as occurs in the Indian disease investigated by Butler(1), although the basal parts of the yellowish leaves were discoloured by large brown irregularly shaped blotches. These did not penetrate any depth into the tissues beneath. The facilities for a careful microscopical examination were insufficient to permit of a detailed study being attempted, but bacteria were found in the neighbourhood of the advancing edge of the rot, and copious mycelium was present in the more distal portions of the central unexpanded frond. Roots and stems, so far as could be ascertained, appeared healthy, and at the time I was of the opinion that infection had commenced somewhere on the youngest leaf, and had travelled downwards.

Apart from the examination of individual trees, data were collected in connection with the incidence of the disease which seem worth recording, particularly as they indicate the lines along which the control of the disease should be followed on the east coast of Africa.

Three observations were made which impressed me very much at the time as being connected with the occurrence and severity of the disease. One was the striking fact that whereas the doum-palm grew nearly everywhere along the coastal belt, the coconut palm did not, but occurred only in patches; some of these palmless areas which I examined were certainly swampy, but whatever the cause may be, the local Swahili natives asserted that they or their forefathers had tried to grow palms on these vacant spots, but always without success. Now it is largely these areas which are acquired by the European planters, and this brings me to my second observation.

In a number of instances which came under my notice, immature nuts had been planted, a practice which cannot be too strongly condemned. The planting out of young palms raised from immature nuts into swampy

ground generally resulted in other diseases besides rot, such as foot-and root-rot, becoming prevalent.

The third and most important point was the effect of sanitation and drainage. On both the plantations mentioned, the manager's house and the huts of the native labourers were, for reasons of health, placed upon the highest and therefore the best drained ground. Palms planted round about the houses and between the huts were much larger, more vigorous and altogether better looking than any others planted at the same time. The former were *always* kept clean, in fact the ground was practically bare of other vegetation ; the latter, as recorded above, were growing in rank grass. Furthermore, the former commenced to bear in the fifth year, whereas the latter never showed signs of bearing before the seventh year after planting. Bud-rot could not be found and had never been observed in the more vigorous palms about the houses and in the native encampment, whereas but a short distance away the disease was rife and the palms of Ceylon origin were without doubt the most susceptible.

From these facts, the conclusion may be drawn, that from every point of view, the planting of smaller areas and keeping them constantly clear of weeds is more profitable than laying out very large, sometimes swampy areas which cannot be kept properly cultivated for want of labour, and planting them up with immature nuts.

In conclusion, I would like to direct attention to the similarity between the bud-rot disease of coconuts in East Africa and the Panama disease of bananas, so far as outward symptoms go. In both diseases one of the earliest noticeable signs is the drooping and yellowing of the outer leaves, which in the banana disease Brandes (2) has shown is probably due to the effects of toxic substances secreted by *Fusarium cubense* at the base of the plants.

A similar thing may happen in the East African but-rot, and a thorough examination for parasitic fungi in the stems and roots of affected palms is much to be desired as far as the east coast of Africa is concerned. At the same time, it is usually unsafe to argue from analogy, particularly in view of Dixon's (3) work on the *descent* of sap, indications of which have also been observed by Brooks (4) and myself (5). The yellowing of the outer leaves in the East African disease *may* be due to the downward movement of toxic substances emanating from an upper and more central seat of infection such as the youngest folded leaf.

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COCONUT BUD-ROT IN TRINIDAD.

MR. W. NOWELL.

About fifteen years ago the U. S. Department of Agriculture issued a bulletin describing at considerable length the researches of Dr. J.R. Johnston into the nature and origin of coconut bud-rot as it had appeared in severely epidemic form in Cuba. The disease was attributed to infection of the crown with *Bacillus coli* or an organism closely resembling it. This conclusion has been generally accepted as applicable to losses of the general type described by Johnston taking place in other parts of Tropical America and the West Indies.

The position in Trinidad in recent years has been that after removing from the category of bud-rot the cases of the now well defined red-ring disease due to a nematode, there remains a very considerable amount of disease of which the symptoms have a strong resemblance to those described by Johnston. Loss of this kind has a scattered general incidence and in several areas has an intense local incidence amounting to an epidemic. Experience so far goes to show that with most of the scattered cases the usual remedy of cutting out the affected trees as soon as they appear is effective, but, in the special areas mentioned, has no visible effect on the steady march of the disease.

It is more than probable that the difference in incidence is associated with differences in causation, and it is in the scattered type that evidence, as yet indefinite, has been seen of the occurrence of *Phytophora* bud-rot as described by Ashby in Jamaica. It is more or less characteristic of this type that rotting of the bud occurs before the outer leaves are visibly affected.

The epidemic form has been subjected to careful investigation for the last three or four years, with results almost entirely negative. All attempts at artificial transmission have failed, whether made by means of cultures of bacteria taken from freshly invaded bud material or by the application of small or large amounts of the affected tissues. These have been made on trees under varying conditions, including sections of the same plantation not reached by the disease but certain to be involved later. Transfer of decaying roots has similarly failed.

It has been established by cutting trees not visibly affected but near the margin of advance that the first visible symptom is the browning of the unopened inflorescence, followed by the shedding of young nuts and the yellowing of the outer leaves. In these early stages the central bud is found to be still quite sound and showing no sign of infection, although the tree is already certainly doomed. As the yellowing of the leaves progresses the bud is invaded by bacterial rot and death ensures.

Our researches so far have brought us to the conclusion that in this type of failure, as has been shown conclusively in red ring disease, the failure of the bud is secondary and the term bud-rot a misnomer.

There is so close a resemblance in the incidence and symptoms of this affection to those of the Panama disease of bananas that of late I have been led to use for it the term coconut wilt to get away from the implications of the use of the word bud-rot. It is exceedingly interesting that as a result of Mr. Dowson's investigations in East Africa he has anticipated me by a few minutes in introducing the term to this conference. The conclusions so far reached by Mr. Dowson, by Mr. Sharples in Malaya, and by my colleague Mr. Snell and myself in Trinidad will be seen to have a very considerable and probably significant degree of similarity.

OIL PALMS

THE AFRICAN OIL PALM.

LECTURE BY MR. T. D. MARSH.

At a meeting of the Central Perak P. A., held on Saturday, February 14, at No. 19, Hale Street, Ipoh, Mr. T. D. Marsh, of the Agricultural Department delivered an interesting lecture on the African Oil Palm and its cultivation in Malaya.

The paper he read was as follows:—

THE OIL PALM (*Elaeis guineensis.*)

This palm which is indigenous to West Africa is gradually coming into great favour in the East as a main crop, and is being planted instead of Rubber or Coconuts. It is undoubtedly the best crop known in lieu of the staple rubber and coconuts and promises to give excellent returns.

It was reported that the area under oil palm in the East Coast of Sumatra had risen to about 35,000 acres in the beginning of 1923.

The palm has during the past ten years received considerable attention, principally because the demand for oils and fats has greatly increased throughout the world. Estates in Sumatra and Malaya that are in bearing are nearly all planting larger areas and more estates are rapidly being opened up.

There is planted in Malaya more than 10,000 acres of which about 1,000 acres are in bearing. Enquiries for land and information about the crop are constantly being received by the Government, indicating a realization by the Planters of Malaya of its value.

The palm is valuable for the two oils, known to commerce as palm oil and palm kernel oil. Authorities in West Africa are getting nervous regarding its gain in popularity in the East as the Plantation oil is cheaper to produce. the yields being higher and is far better in quality than the native product.

VARIETIES.

Many varieties have been described and named, and several are being grown in the Kuala Lumpur, and Serdang Experimental Plantations. The Kuala Lumpur palms are in bearing, but the general impression throughout the East is that the Deli type which is being grown in the N. E. I. and Malaya is the best type to grow locally, it is *Elaeis guineensis* var. *dura.*

Lisomb type, *Elaeis guineensis* var *tenera* appears to be the ideal type, it having a very thin shell but its drawback is that it does not breed true to type, and probably requires years of selection to make it safe for plantations.

It is doubtful whether there are any distinct varieties and, may be, they are only types of the one variety, showing variation in composition and character of the fruits.

Numerous experiments are being conducted on the palms on an area planted on the Government Experimental Plantation, Serdang, and the

question of types and varieties and the production of more suitable strains will be investigated.

These variations consist principally in the percentage of the pericarp and its oil content, the percentage of kernel and its oil content and the thickness of the shell. What is required is a palm producing large crops of fruit with thick pericarp having a high percentage of oil together with a thin shell and high percentage of kernel of high oil content or in other words we want the strain of palm which will produce the maximum amount of oil of best quality with the lowest costs of collection and manufacture.

The Deli type produces the largest fruit of the types being tried in Sumatra and Malaya.

CULTIVATION.

From observations made, the palm prefers alluvial soils that are well drained and will probably give best returns on coastal areas in the vicinity of the big rivers.

Palms grow very well on most soils except peaty, sandy or swampy areas. They will grow inland on gently undulating land and are being grown at an elevation of over 1,000 feet above sea level in Sumatra and are yielding well at over 2,000 feet in the Cameroons. Shallow peats overlying clays are not so objectionable.

It is necessary to prevent the loss of top soil by erosion from the time of clearing the jungle, and especially on undulating land, the usual precautions must be taken such as planting on contour, weeding systematically to eventually form terraces, silt pitting from which the soil is thrown above the pit to also form terraces and the growth of leguminous cover crops.

It is not usually recommended to grow catch crops although coffee or other suitable catch crops may be grown between the palms to provide revenue until the palms are in bearing.

The oil palm is propagated from seed, the time taken for germination varies considerably and when undertaking a planting programme it is necessary to help germination as far as possible so that plants may be available when required. Fresh seed is desirable and after removal of the pericarp, the seed is sown in pure sand in the sun and kept moist by constant watering, in this way a fairly high percentage of germination can be obtained in 2 to 3 months. Immediately the young leaf sheaths appear the seedlings are removed and transplanted in well prepared nursery beds about 12 to 18" apart each way, where they are left for a period of about 8 to 12 months until they are planted in the field. Many estates plant the seeds in well prepared nursery beds, rich in humus consisting of leaf mould and cowdung and without shade, the beds should always be kept moist, for convenience the beds should be close to water. Young seedlings without shade grow hardy and stocky whereas under shade the palms are inclined to get more leggy but make a faster growth. The plants may be put out in the field as small seedlings or up to 2 or 3 years old, but experience shows that 8 to 12 months old is best. Old seed is very slow in germinating and may take 12 months. All kinds of experiments are being conducted to find a method of quick germination. Hot fermentation, etc.

The distance apart of planting recommended is 30 ft. by 30 ft. on the equilateral triangular system which gives about 55 palms per acre. Sumatra 9 to 10 meters which is 28 to 32 feet. Holes are dug deeper than necessary for the plant and partly filled in by surface soil and the seedlings planted with the base of the leaves just above ground—it is essential that the leaves of the plants be kept above the level of the ground and deep planting must be avoided. The young palms withstand transplanting fairly well if the operation is carried out when the land is moist and during rainy weather—if dry weather sets in, then it is advisable to shade the plants with a few leaves until they are established.

The after-treatment consists of preventing erosion of surface soil, growing cover crops, and I would say that during the first few years *Calapogonium mucunoides* is likely to give good results at least until the palms throw too much shade. Giant mimosa kept away from the young palms is very popular in Sumatra. Sarawak bean is a very fine cover and will continue to grow under shade, and *Centrosema plumieri* and *C. pubescens* are to be recommended. Any of these covers will give good results for a few years on soils suitable for the growth of oil palm if they are established immediately after clearing the jungle. At the same time when choosing a cover I would pay due attention to the class of soil suitable to each one.

On the coastal areas it is advisable to cut "rantas" through the virgin jungle before clearing, and cut main drains to lower the water table before felling and burning, afterwards it is essential that the subsidiary drains be cut as the palms will not thrive in stagnant water, and on such land weeding costs are much higher and covers do badly. On land with a high water table scupper drains may be cut between the rows of palms and the soil thrown towards the palms, and in the monthly round of weeding the soil should be gradually worked towards the palms forming a wide ridge and shallow furrow.

Very little has been done in the way of manuring, but in mature palms the soil could with advantage be enriched by the ploughing in of green manures, or the growth of such plants as the *Tephrosias* or *Crotalarias* which are periodically pruned and the leaves and stems allowed to cover the ground forming a green nitrogenous manure and mulch.

The palms come into bearing about the third or fourth year after planting in the field.

PRUNING.

It is customary to prune the leaves at the base of the crown of the palms, but the leaves below the bunches of fruit should not be cut until the fruit is ripe, and as this pruning, if excessive, is liable to limit the producing capacity of the palms, the leaves being the manufactories of the plant, very mild pruning is necessary. In the past it has been observed that severe pruning has resulted in smaller fruit and reduced crops. Pruning has the effect of stimulating production of fruit for a time, after which the yield falls off, also the trunk of the palm grows thinner during a period of severe pruning and the palm grows taller than usual. Various degrees of pruning are being tried at the Government Plantation, Serdang.

POLLINATION.

In Sumatra it was observed that many palms produce female flowers but little fruit and it was thought that the flowers were not fertilized by the pollen of the male flower. This has since been proved by experiments in Malaya and Sumatra to be the case. In Kuala Lumpur by artificial pollination the palm has been made to produce bunches containing over 50% by weight of fruit whereas under natural pollination the percentage of fruit on the bunches dropped to below 20%. It has become a recognised estate practice to artificially pollinate female flowers at least on young palms and regular patrols are organised to carry out this work, and it is usual to patrol the estate once every three days; a cooly can pollinate about 20 acres a day or 60 acres in the three days. The operation is as follows:—The male flowers are sought for and cut when ripe, that is when they emit a strong smell of aniseed and are shaken in a large funnel which is placed over a bottle or other receptacle. The pollen if kept dry will germinate for some time after collection but it is advisable to use it as fresh as possible. The female flowers also emit the same scent when in a receptive condition, they only remain in this condition for about three days The pollen is dusted over the bunch of female flowers by a simple duster made from a tin with the lid perforated, the leaf stalk above the flower is marked with paint to record the operation, a different mark for each month is advisable; it facilitates harvesting. It is recommended in this way to breed from the best selected palms on the plantation for seed purposes by protecting the female flowers for a few days before and after fertilization. It is impossible to fertilise the flowers a day earlier or later than the receptive condition. Experiments and pollination are at present being conducted on young plants at the Government Plantation, Serdang.

THE BUNCHES ARE RIPE ABOUT 6 MONTHS AFTER POLLINATION.

Experiments have shown that artificial pollination can be carried to excess, resulting in reduced size of fruits and a thinner pericarp; the extent to which this operation may be carried on will depend on the quality of the land, cultural methods, etc. It is a question that will have to be determined on each Estate.

The crop is not evenly distributed throughout the year, and it is reported that the maximum crop is obtained during the dry season so that when installing machinery for dealing with the crop it is necessary to have a plant that can deal with more than the average yield.

As the palms get older and taller the costs of harvesting become higher. The bunches are systematically cut when ripe, and placed in long collecting sheds, in which they are stored on open racks of bamboo or wood—the fruit falls into a sloping catchment shelf placed below. Many of the fruits ripen in a day or so and fall on to the shelves below, and the remainder is removed fairly easily by hand. The separated fruits are then taken to the factory and treated as soon as possible—the oil from fruit that is stored too long, especially in heaps, or damaged by careless handling, deteriorates and free fatty acids are rapidly produced by a fat splitting enzyme present in the pericarp.

This is a very important point and the smaller the percentage of free fatty acid in the oil the greater its value. It must be the object of every estate to extract the oil from the fruit in the shortest space of time after it is ripe.

YIELDS.

Individual palms may yield from 6 to 10 bunches per annum and the weight of picked fruit per palm may vary from 45 to 145 lbs. per annum according to age.

The following table gives conservative estimates based on palms planted 55 per acre and calculated on the average percentage of pericarp, palm oil and kernel.

Reference Bunting and Georgi—Malayan Agricultural Bulletin, June and July, 1924.

Age of Palm	Fruits per palm per annum	Fruit per acre	Pericarp per acre	Palm Oil per acre	Palm Oil Output per acre (85 % of total)	kernels per acre
4th Year	45	2,475	1,436	767	652	173
5th to 7th	90	4,950	2,872	1,534	1,304	346
8th to 10th	100	5,500	3,190	1,705	1,449	385
11th to 15th	125	6,875	3,988	2,131	1,811	481
16th to 30th	145	7,975	4,626	2,472	2,101	558

The Composition of Oil Palm Fruit of Malaya.

				per cent.
Fruit	Pericarp 58 per Cent.		Moisture	33
			Palm Oil	53
			Residue	14
				per cent.
	Nut 42 per cent.	Shell 85 per cent.	Palm Kernel Oil	43
			Moisture	15
		Kernel 15 ,,	Residue	42

Proportion of Palm Oil on whole fruit=31 per cent.

Proportion of Kernel on whole fruit=7 per cent.

Over the whole fruit there is about 3 % of Kernel Oil.

It will be seen that palms in full bearing will produce in round figures about 1 ton of oil, and about ¼ ton of kernels per acre per annum and as the oil content of the pericarp is about 31 % roughly 3 tons of fruit must be treated per acre per annum.

On a 1,000 acre Estate about 3,000 tons of fruit would have to be treated. On a basis of 350 working days per annum, about 8 tons per day, or 1 ton per working hour would have to be treated, but as the crop varies monthly, some months producing twice as much as others, it would be necessary to instal a plant having the capacity for a larger output, and during some seasons it may be necessary to work overtime.

Experiments in Medan, Sumatra, were carried out with a mechanical threshing machine for separation of the fruits from the bunches. It was found that the bruising of the fruits produced a very high free fatty acid

content of the oil, but by immersing of the bunches in boiling water before threshing the enzyme was destroyed and the chemical change was stopped and an oil with a low percentage of free fatty acid was produced.

Comparing the usual method with the threshing machine the disadvantages of the threshing machine method are that about twice the amount of material must be transported to the factory (about half of the bunches being waste) and that larger heating vessels are required.

The advantages are that no collecting sheds are necessary in the field and less labour is required. Reports state that the threshing machine method is the most economical.

In Sumatra I understand Estates have been satisfied with a percentage of free fatty acid not higher than 7% but the West African product is sold on a basis of 18% Free Fatty Acid, a premium is paid by the buyers for oil with a free fatty acid content below this amount at 1*s.* 9*d.* per cent. per ton. Free Fatty Acid in West African oil goes up to 50% — it should be brought down to 3 or 4% in the plantation product.

Up to recently the great problem with this crop has been machinery, which has been very expensive and inefficient, but Mr. B. J. Eaton describes two different makes of machinery in detail in the Agricultural Bulletin of December, 1924, one of which he has had the opportunity of observing at work at Wembley Exhibition and he states that the one he saw is a great improvement over earlier machinery, is almost automatic in action, is very efficient and simple in operation with prices comparatively moderate and can be supplied in any capacity even down to hand power. Tennamaram Estate in Salangor has one of these plants installed and in daily use. The one at Wembley having a capacity of 2 tons per hour had only two attendants.

The plant in question is being made by Messrs Manlove Alliot & Co. of Nottingham—for Nigerian Products, Ltd., the other plant is made by Culley Expressors, Ltd. This can also be supplied to treat 10 cwt. per hour down to hand power.

I would recommend any one interested to obtain the Malayan Agricultural Journal of December, 1924, and read Mr. Eaton's article. He describes both these makes of machinery in detail, giving the process in each case and comments on them.

The price of the Nigerian Products, Ltd., machine made by Messrs. Manlove Alliot & Co. Nottingham including engines, boilers, shafting and supports, packing and delivering to English port F.O.B. is about £6,500 for a plant having a capacity of about 2 tons per hour.

Culley Expressors, Ltd. supply a plant with a capacity of about 10 cwt. per hour picked and delivered F.O.B. English port £2,500, this does not include boilers, engines and shafting, etc.

Briefly the extraction of the oil and treatment of the fruit is as follows:—In the Manlove Alliot process the fruit is placed in a digestor and treated direct with steam to destroy the ferment, then it is placed in a centrifuge and the pericarp oil is expelled from the whole fruit—this operation also partly separates the pericarp from the nut, this is completed by a rotary separator. The oil is pumped to settling tanks heated by steam

coils to coagulate the suspended matter and afterwards run off into storage tanks from which casks are filled for shipment. It might be advisable to pass the oil through a filter press. The nuts are cracked by machines and the shells are separated from the kernels by immersion in brine, clay suspended in water acts equally as well as lime but is not so clean though it is cheaper, the shells sink and the kernels float. Tennamaram Estate have found it necessary to sterilize the fruit before using the M.A. & Co. Machinery.

In the Culley Expressors, Ltd., process, the fruit is placed in a steam jacket digester, and the steam does not come in contact with the fruit. It is afterwards depericarped in a patented machine without water, for which it is claimed the objections to former machines have been overcome. The oil is separated from the pericarp by a centrifugal extractor. It is then pumped into settling tanks and from this it is filtered into storage tanks, or casks for export. The nuts are cracked, and the kernels separated from the shells much the same as the former process.

The Culley people state that the water or steam direct on the fruits cause a development of Free Fatty Acid and glycerine which is lost in the water. Mr.B.J. Eaton is of opinion that this is of no consequence.

The kernels are exported in sacks and in view of the demand for them in the Home market it is unlikely that the oil will be extracted in this country. The kernel residue after the extraction of the oil is used as a food for stock.

One or more Sumatran estates are extracting the oil from the residue with a solvent instead of final pressing or centifugal machinery. The solvent which is benzine is recovered, and used over and over again; I would say that if a solvent is used then the whole oil should be extracted in this way, and eliminate all the other machinery. The solvent extraction will remove all the oil from the pericarp.

BARRELS.

At present Californian fir and English oak casks are used costing about $ 8 per cask. Experiments are being conducted in the Forests Departments of Malaya and Sumatra to endeavour to find suitable local woods. Metal containers have been used in the past with little success, they being more expensive than casks.

Palm oil is used in the manufacture of soaps, candles, lubricating greases, and in the manufacture of tin plate; high grade oil (that is pericarp oil) is used for edible fats. In view of the larger supplies of plantation produced palm oil which is as mentioned previously of higher quality than the native product—this market is likely to expand and palm oil will compete with coconut and palm kernel oil in the preparation of substitute bu ter and cooking fats.

Experiments in 1917 were being conducted in Belgium in running a crude oil engine on low grade oil with reported success.

Palm kernel oil is principally used for edible purposes. I might here mention that the F.M.S. Railways have reclassified palm oil freights from rates at 4/5 of a cent per picul per mile which is the ordinary freight on oils to 2/5 of a cent per picul per mile.

PESTS.

The pests so far have not been very serious, but, when large areas are planted we must expect more damage, and consequently greater costs will be involved in keeping them in check.

The pests so far noticed are the same as attack the coconut palm and, the principal ones are the coconut beetle (*Oryctes rhinoceros*) and Red striped weevil (*Rhynchophorus schach*).

There is a disease which affects young palms and is known as "Crown disease." This causes the leaves to fall down and the crown gets a twisted appearance. As a rule after some time the palm recovers and assumes the normal growth. This disease has not been investigated as far as I know, but it probably has a physiological origin and may be due to the overgrowth of the leaves in comparison with the roots.

Rats, pigs and porcupines have been observed to damage the bunches of fruit on young palms, and to pick out the seeds from the nurseries. Unripe fruits damaged by pigs may be harvested when ripe without fear of giving a high percentage of Free Fatty Acid.

Experience in Malaya has proved that this crop is well worth cultivating.

Tennamaram Estate expect to pay a dividend in 1925.

A comparison of coconuts and African oil palms at 10 years old will be of interest.

The yields of the oil palm are based on estimates only, as per the table mentioned earlier.

Coconuts, say yielding 60 nuts per palm per annum and 55 per acre gives 3,300 nuts per annum or about 16 cwt. of copra.

16 cwt of copra at £29 10*s*. per ton = £23 12*s*. which is a very high yield and much above the average.

OIL PALM RETURNS.

Say 10 year oil palms produce 16 cwt. of oil at 85% extraction and 4 cwt. of nuts.

London prices September, 24th	Sumatra oil	£36 2*s*. 6*d*. per ton	
	Palm kernels	£20 15*s*.	
	16 cwt. oil	£28. 18*s*	
	4 ,, kernels	£4 3*s*.	
			£33 1*s*.

The oil below 18% Free Fatty Acid would obtain a premium of 1*s*. 9*d*. per cent. per ton, for each per cent. below 18% as granted by the buyers, and with improved machinery this should be brought down to 3 or 4%. The yield of oil palms will increase probably for several years after the 10th.

The cost of depreciation and running machinery must be charged against the oil palm as no machinery is necessary in the preparation of copra.

The above estimates of oil palm returns are probably on the conservative side under good cultural methods.

I might here mention a few main points in the acquisition of State land for the cultivation of the African oil palms. Premium of $3 per acre or such smaller sum as is approved by the Resident.

Rent 50 cents per acre for 6 years and thereafter $2 per acre. Export duty 2½% *ad valorem* or such other rate as is from time to time published in the *Government Gazette*.

Land shall be used solely for the growth of an oil palm or such catch crops as are approved of by the District Officers.

On areas over 200 acres 10% of the area must be reserved for food production.

There are also rates of planting per year and labour conditions.

For further information on African oil palm please refer to :—

Malayan Agricultural Journal, June and July, 1924, "The Oil Palm in Malaya" (Bunting and Georgi).

Malayan Agricultural Journal, December, 1924, "Recent development in Oil Palm Machinery" (B. J. Eaton).

Malayan Agricultural Journal, April-June, 1921, "The Oil Palm in Sumatra," (J. N. Milsum).

—The Malayan Tin and Rubber Journal, Vol. XIV. No. 5.

PALM-OIL AND ITS CONSTITUENTS.

The following extract is taken from "Vegetable Oil Notes" in *Tropical Life*, Vol. XX. No. 2.

Palm-oil, as it exists in the fresh fruit, is an almost neutral fat, consisting of 10 per cent. glycerin, in combination with various fatty acids. During the extraction from the fruit, fermentation inevitably occurs to some extent, and part of the oil is split up into glycerin and F.F.A. (free fatty acids); the oil then shows a marked acidity. The percentage of these f.f.a. in a sample depends on the extent to which fermentation has occurred; it is therefore an indication of the method by which the oil was prepared. The freed glycerin, unlike the f.f.a., is soluble in water and is believed to be lost during the extraction of the oil for this reason. It is assumed, therefore, that the f.f.a. content of an oil is inversely proportional to the glycerin content and that each 10 per cent. of f.f.a. indicates a 1 per cent. loss of glycerin.

In soap-making, only the f.f.a are required, the glycerin being a by-product. It is, however, so valuable that oils with a high glycerin content, and so with a low percentage of f.f.a. command a higher market price chiefly on this account. In addition, very high grade oils (with not more than 8 per cent.f.f.a.) would have a special market, for, after the removal of the free acid, the oil can then be utilised as edible fats.

Quality in oils may be taken as referring to the percentage of f.f.a. The trade terms "Hard" and "Soft" being used in this respect. Actually, the melting-point of a sample is not always correlated with its f.f a. content, though usually the two bear a superficial relationship, hence the origin of the trade terms. The term "Hard Oil" refers to oil prepared from fruits in which fermentation has been encouraged.—

RUBBER.

LATEX PAPER

B. J. EATON.

Some three or four years ago, considerable interest was aroused in the rubber and paper and pulp world as a result of investigations carried out by Kaye on the addition of latex to pulp for the manufacture of paper.

It was originally suggested by Kaye that the addition of latex to pulp in the manufacture of paper reduced considerably the time of beating required for the manufacture of the pulp and it was considered possible to prepare a cheaper and stronger paper by the addition to the pulp of latex equivalent to 1 to 3 per cent. of rubber on the weight of pulp. Although no information as to cost is available at the moment, about a year ago, when our investigations were commenced, the price of latex paper was about 20 to 30 per cent. higher than that of similar grades of non-latex paper.

Except for (a) sentimental reasons, in respect of firms, estates and others who were interested in the consumption of more rubber and new uses for the commodity or (b) for special purposes in which a stronger or more durable type of paper was required, such as for documents which have to be stored or (c) unless the addition of latex cheapened the cost of manufacture, the use of latex in paper manufacture was not likely to be a success.

The application of latex to newsprint paper would only be successful, if the paper could be produced more cheaply, which does not appear to be the case up to the present. The use of latex paper therefore would be confined to paper required for special purposes, principally for documents which have to be stored. The most desirable property of such a paper is its keeping qualities or non-deterioration on storage. The results of several previous investigations carried out in the Bureau of Standards, United States of America, and by other workers indicate that any superior qualities conferred on paper by the addition of latex to the pulp are lost after the paper has been stored and this is attributed to the resinification of the rubber. Owing to the fact that the amount of latex or rubber originally added to the paper tested was unknown, as also the original resin content, no investigations were carried out by us to determine whether the rubber originally added to the papers in the form of latex was resinified since such an investigation would have been of no value in the absence of such figures. It seems highly probable however that the rubber would be converted into resinous substances during prolonged storage or under accelerated ageing conditions.

In *The Rubber Age* (Volume V. No. 9, November, 1924) published in England, Kaye has replied to various criticisms of latex paper which were based on investigations on latex papers carried out in America, and elsewhere. The figures given in his reply however do not appear convincingly favourable to latex paper when compared to similar results quoted for non-latex papers, especially in regard to durability tests.

The deterioration on storage appears to be not less in the case of the latex papers than in the case of the non-latex papers.

The following tests in all cases show appreciable deterioration in the case of both latex and non-latex papers with no advantage to the former.

The bursting strength in both cases generally increases on storage, which appears somewhat unexpected, although the increases are comparatively as much in favour of the non-latex papers as of the latex papers.

The mean breaking lengths both before and after storage are somewhat in favour of the latex papers, while the breaking strains are slightly in favour of the latex papers. It would appear however that the original tests were carried out in the U. S. A. and the tests on the stored samples were carried out in England. The different conditions may account for the superior results shewn for the samples after storage.

The report contained in this journal on investigations carried out in The Chemical Division of the Department of Agriculture at the request of the Honourable the Chief Secretary to Government deals with various samples of paper received from the Government Printing Department and other samples obtained locally. Although it was not possible in every case to examine comparative samples, *i.e.* papers manufactured in a similar manner and containing similar constituents, apart from latex on rubber content, the results obtained, especially in the accelerated ageing tests, confirm those which have been published by other investigators and shew that, as far as these samples are concerned, the presence of latex in the paper does not appear to render the paper less susceptible to deterioration than papers which contain no latex.

Unfortunately owing to lack of paper testing apparatus it was not possible to carry out complete physical tests on the samples.

In our opinion the application of latex to the manufacture of paper does not appear to hold any very definite promise of success in respect of its utility, either for ordinary purposes or in the case of papers for documents which have to be stored, unless the application of latex lowers the cost of manufacture. The application of latex to pulp in the manufacture of paper does not appear to improve the surface for printing purposes, but it is probable that the demand for latex paper on account of this factor would be limited.

It seems probable however that the application of latex to the manufacture of latex boards for containers and other purposes, in which ordinary paper boards or cardboards are used, offers more promising possibilities. The vulcanisation of such mixtures of rubber (added in the form of latex) and pulp, after conversion into latex board will also probably increase the utility and application of rubber for such purposes.—The Malayan Agricultural Journal, Vol. XIII. No. 3.

CACAO.

SOME BOTANICAL PROBLEMS OF CACAO.

S. C. HARLAND, D.Sc. (LONDON), F.L.S.

(The following article forms the substance of a recent address by Prof. Harland to the Trinidad and Tobago Agricultural Society.)

One of the most striking features of a cacao plantation is the enormous variation in yield from tree to tree. Of two trees both apparently similar in healthiness and vegetative vigour one will yield a hundred or more pods and the other few or none. A similar situation is characteristic of other tropical tree crops, for example, it has been noted in the East in rubber that 75 per cent. of the crop is often being produced by less than 30 per cent. of the trees. This means that a large number of trees are not paying for their keep and may be described as 'boarders' The situation is most nearly analogous to that existing in a commercial herd of dairy cows. As long as the farmer is content to record the amount of milk he receives only in bulk, he cannot take any steps towards improvement, but when he begins to record the individual milk yields he soon discovers that certain cows are not worth keeping and replaces them by better animals. To analyse a little further, the low milk yield of some cows may be due to inadequate nourishment or to disease, but everyone knows that if a cow is inherently a poor yielder, no amount of care and attention will ever effect any improvement. As we say in Yorkshire, "You can't get a quart out of a pint pot."

It is enormously important for the cacao planter to eliminate the poor yielding trees, and to replace them with heavy bearing types. But before we can do this a certain amount of initial study is necessary on the way in which the yield of a cacao tree is built up. In the first place pods come from flowers, and we have to decide first whether the small yield of pods in some trees is due to a correspondingly small number of flowers. A little study will show that as a rule the number of flowers has very little, if at all, to do with the size of the crop, and it is often the case that the unproductive and barren trees are producing large flushes of flowers but are not setting any pods.

Since mere number of flowers is not of great importance it is clear that a study of the pollination and the setting of fruit in cacao is an essential preliminary to the wider question of how yield is built up. We have carried out an extensive series of experiments at the College on the question of pollination and our results may be briefly summarised as follows :—

1. Direct observations by the microscope have shown that only about 5 per cent. of flowers ever received any pollen in their stigmas at all and 95 per cent. are therefore doomed to pass through their life history without any chance to set fruit.

2. If flowers are hand-pollinated there is a survival of 5 per cent. of the flowers on the 10th day, at which time small fruits have developed of 2-3 mm. in diameter. After this period there is practically no further loss by

mere shedding, though many fruits fail to reach maturity either through disease or lack of nutrition.

3. The setting percentage of 5 per cent. in hand-pollinated flowers should be compared with the figure 0·3 per cent. in non-pollinated flowers.

4. In flowers attended by ants and aphides, about 2 per cent. of setting occurs and we have calculated that efficient pollination takes place in about 35 per cent. of flowers attended by ants and aphides.

5. The results of flower examination, involving the recording of the history of nearly 4,500 flowers by my assistant Mr. G. O. Johnson, having established beyond reasonable doubt that either ants or aphides or both these insects, are responsible for a considerable amount of pollination, and the low percentage of setting on control flowers renders it likely that they constitute the chief pollinating agents at the St. Augustine Experiment Station where our experiments were carried out. It is conceivable that thrips of the flower-inhabiting type (not the injurious species), also play some role, but they were practically absent in our material.

6. Elimination of crawling insects by bands of an adhesive substance demonstrated the presence of another pollinating agent, probably a night-flying insect which efficiently pollinated about 1 per cent. of flowers.

We can now proceed a step further. Though the percentage of pollination is small and the percentage of flowers which set fruit seldom rises above 5 per cent. ; it is probable that lack of pollination is never the main cause of a poor crop, for nature provides such an enormous number of flowers that the setting of even one in a thousand would produce a heavy crop. Our experiments in hand-pollination led us, however, to an important conclusion. In certain trees—unproductive trees, several hundred flowers were pollinated without a single pod being set, but on other trees—good bearing trees, a large number of pods could be set at any time by hand pollination. We have thus arrived at what is probably the main factor distinguishing productive from unproductive trees; the former are good "setters" and the latter bad "setters." It is clear that from the practical point of view the elimination of poor "setters" is entirely feasible, and the breeding out of a strain of high setting capacity could be done without the slightest difficulty. Certain varieties of cotton for example suffer unduly from the shedding of buds, flowers, and young fruits, and it has been possible to isolate strains comparatively free from shedding.

The breeding of a variety or varieties of cacao of uniformly high productivity offers a few difficulties which merit some discussion. A tree may be regarded as the resultant of the interaction of its hereditary factors plus its environment. There is no such thing as a cacao which breeds true to type, for we have shown by methods which are somewhat too detailed to relate here that cacao is cross-fertilised in Trinidad to the extent of about 30 per cent. There is a kind of tree which occurs sporadically on estates under the name of "Male Cacao," which is characterised by complete sterility of the anthers and should therefore be more properly termed "Female Cacao." Examination of the stigmas of flowers of such a tree will show that pollen is being conveyed from neighbouring trees, probably by an unknown night-flying insect.

The existence of such a large amount of natural crossing means that the cacao trees of Trinidad are a set of extremely complex hybrids, whose progeny show the usual type of Mendelian segregation. The main fact

about a hybrid is that it cannot breed true, so that the mere taking of seed from high-bearing trees will not insure a high bearing progeny. Nevertheless, the progeny of some trees will show a higher mean yield than the progeny of other trees, and what must be looked for first is the ability to transmit yield rather than the actual yield of a tree itself. Boiled down, the theory of breeding cacao is this, that the value of a tree for seed purposes can only be estimated by taking the average yield of its daughter trees, and using this as a basis for selection. I need not elaborate the theory any further; its exact working out is somewhat difficult and demands a knowledge of the working principles of genetics. But in closing my remarks on breeding for high productivity in cacao I shall draw your serious attention to the fact that while the entomologist and mycologist have had a fair scope for their work, the specialist in plant breeding has never had a chance and it is time that he had one. If you had a cacao experiment station in which a hundred self-fertilised progeny were grown in rows from each of 500 high bearing parents from all over the island, it would not take more than a few years, say three generations, before trees guaranteed for high productivity would be available for wide distribution.

To turn for a moment to another aspect of yield, it has been thought that by using budded trees from known heavy bearers, fields of uniformly high productivity could be obtained. There are, however, difficulties in the way of such a supposition. In the first place, it has been shown that yield depends considerably on "setting capacity." When you bud a tree, does the "setting capacity" follow that of the stock which is an unknown quantity, or does it follow that of the scion? There are many reasons for believing that the stock in this connection is at least as important as the scion, and it has been shown in cotton that a shedder can be partially converted into a non-shedder by the employment of a suitable stock. The converse of this is also true. Experiments with grafted and budded rubber in the East have also led to the conclusion that the stock is of very great importance in influencing yield, and the Dutch workers are now of the opinion that the only test of the value of a tree for budding purposes must be based on an examination of its vegetative descendants. If a tree produces good vegetative offspring it is a good tree; if it does not, it is a bad tree. The figures obtained for the yields of budded cacao at River Estate indicate that some of the budded strains are good, while others are decidedly bad. I believe that there is room for both budded and seedling cacao in Trinidad, but the future for the latter is probably greater. It is important to note also that the seeds from budded cacao though uniform in size need not necessarily be uniform in quality, for if a budded Forestero is pollinated by Criollo pollen the resulting seeds will probably partake somewhat of the Criollo quality. That is, Mendelian segregation may take place in a single pod with respect to quality and there may be half-a-dozen qualities present in such a pod. The unit of quality must therefore be taken as the single bean.

Before closing, I should like to emphasize the point that the manufacturing end of the cacao industry is a quarter of a century behind that of the cotton industry in its attitude towards its raw material. The cotton spinner now realises that uniformity of quality is based on pure strains of cotton, and he realises that all his manufacturing processes are based on the behaviour of a single cotton hair as the unit. When the cacao manufacturer realises the importance of linking up his activities with those of the grower, we shall then, and not until then, be able to breed cacao for quality. At present we cannot do this because the manufacturer has not reduced definition of quality to exact scientific terms and until quality is analysed in a precise manner from the chemical, physical, and botanical points of view the plant breeder will continue to be held up.—Tropical Agriculture, Vol. II., No. 3.

SUGAR CANE.

SUGAR CANE CULTIVATION IN LOUISIANA.

The following is a summary of the article on "Sugar Cane Cultivation in Louisiana" by C. A. B., which appears in the *International Sugar Journal*, Vol. XXIII. No. 314.

A Committee including members of the United States Bureau of Plant Industry, the Bureau of Agricultural Economics, the Louisiana Agricultural College, the Bureau of Entomology and that of Home Economics enquired into the environmental conditions of Louisiana with regard to the economic stability and the future prospects of the Sugar Industry, and especially, in view of labour stringency about the current agricultural practices—the results of many years of accumulated experience and scientific study—dealing primarily with the crop of 1922.

The report of the Committee deals with the production of sugar in the United States and confines its attention to the continental section. It is to the economic study of cane cultivation that the Committee chiefly devotes itself, all the phases of cultivation being considered in turn and set out in terms of crews employed, number of acres worked per day, etc. Although the sugar industry is dealt with from all aspects, the major portion deals with production in the field. The opinion of the Committee was based on the environmental conditions in Louisiana, the difficulties in which the industry finds itself placed, and its future prospects.

The sugar-cane is a tropical plant, which connotes certain requirements for optimum growth. These are briefly high temperature, ample sunshine and a continuous supply of water during the year round. The best growing conditions are such as those obtaining in hot humid climates, where torrential downpours quickly give place to periods of brilliant sunshine. It is a perennial tufted grass which has adapted itself to the usual seasonal changes of the year. Its individual shoots require one year to complete their growth, and end in a feathery plume of flowers at a certain period, more or less definite for each locality. As no further growth can be expected from the shoots that have flowered, fresh ones appear, chiefly at the base and form the canes for the next year, which in their turn mature and form flowers at a given time. These shoots always contain sugar instead of the more usual starch in their storage cells; but this is of two kinds, crystallizable and non-crystallizable which vary greatly in their relative proportions during growth. The amount of the latter is considerable during the earlier stages, but towards the end the former greatly preponderates, and yields the juice needed for the extraction of commercial sugar. The cane is called, technically, mature or ripe when this stage is reached, and the juice is called rich or pure; but this condition does not accurately coincide with the time of flowering, and full ripeness generally occurs some

little time after the flowering period has ceased in a crop. While warm, humid weather is desirable throughout the growing period, cooler and drier air are more favourable to the process of ripening.

As Louisiana is well outside the tropics, the warm period is insufficient for the full development of the cane, although this is to a certain extent got over by the introduction of early maturing varieties, namely, the local Purple and Ribbon canes and a Demerara seedling, D 74. Even thus the canes reaped are unripe and flowering does not occur. During the short growing period, a well distributed rainfall gives the necessary humidity, and ample sunshine is available, stimulating conditions in the tropics. But it is obvious that any period of drought, which may occur in any crop solely dependent on rainfall, or even a succession of cloudy days although accompanied by rain, will check growth and decrease the crop. The cooling of the air and diminution of the rain in the autumn, while limiting the period of active growth, assist in the premature ripening of the canes. The main drawback in the United States cane sugar industry is thus seen to be in the climatic conditions.

In the locality marked out above, the soil appears to be exactly suited to the optimum growth of the sugar-cane; it is suggested that nowhere else does this plant grow more rapidly except in N. India where similar conditions prevail. The cane which chiefly grows on the Sharkey clay, which is rich, has its importance in that it is highly retentive of moisture. It is pointed out that wherever irrigation has been introduced it has proved economically sound not only on arid tracts but also where sufficient rain falls, the additional expenses being made up by the increased yields. But any such work would have to go hand-in-hand with a very thorough system of drainage. The cutting of drains is an important item in the preparation for planting and cultivation, but the keeping of the drains in order appears to be less carelessly attended to than it should be. The system used is one of open ditches, and all that is required is to enable the occasional torrential downpours to flow off rapidly. The sugar-cane will survive a flow of water over the surface without injury, but is peculiarly sensitive to stagnant water, which destroys the crop.

In the tropics the cropping season may be spread out for several months, but must be done very quickly in Louisiana. As soon as a forecast is issued indicating a fall of temperature to 26°or 27°F. all hands are turned to cutting the canes and hurrying them to the mills. If all the mass of canes rushed in is not dealt with, the surplus is "windrowed" or bedded in the ground and the temporary storage does not appear to decrease their sucrose contents.

In Java and Formosa the seed required for each crop is obtained from special nurseries: and the obvious advantages of dissociating planting from factory work is being widely canvassed in other countries. The two seasons for planting the cane in Louisiana are, in autumn, commencing about October 15th; in spring, in January up till, sometimes, April. The preparation of land is the same in both except that spring planting is more expensive due to the windrowing of the seed cane from the frost. There seems to be conflicting views as to which time for planting is really the best.

A wet winter will cause much damage to the autumn-sown crop by rot, and if the soil becomes dry many young plants will wither and dry up, and the same effects are produced on the windrowed seed. But the sponsors for spring planting point out that they have a much better chance of obtaining a full stand of canes for the crop, in that they can select the seed which has come through safely—which suggests that a good deal of waste occurs in any case, in windrowing more seed cane than may be actually required. The Committee are justified in their conclusions that the work suffers from the rush and uncertainty at the end of the season, the scarcity of labour being mainly responsible for this state of affairs, a new adverse factor is introduced of almost equal importance as the climatic conditions.

A three-year rotation is usually practised in the cane fields; corn (maize) and cowpeas, plant cane, stubble cane (ratoons). The corn is planted early in spring, and peas are sown in between the rows at the last cultivation. The corn is not a profitable crop being planted at the usual cane row distance and little labour is devoted to it. It gives a certain quantity of grain and some fodder for the mules, and is useful in preparing the seed bed for the peas and in supporting them in their growth. The object of the peas is to replenish the soil with humus and nitrogen taken out of the soil by the two crops. In preparing the land for cane the whole of the vines is buried leaving a certain quantity to mix with the corn stalks as fodder. The deficiency in the quantity of nitrogen is made good by adding cotton seed meal as a manure. The quantity applied is 400-600 lb. for plant canes and somewhat more for ratoons. The whole or a part of the artificial manure is applied in the furrow at planting time; if a part, the rest is scattered along the sides of the young plants after the first cultivation.

The Committee note that the future of the Sugar Cane Industry in the United States, while limited climatically, is not necessarily so as regards area, and is capable of expansion even with the present varieties of cane.

The limiting factors appear to be rather economic than agronomic, labour supply, market price of sugar, and assurance of protection, all of equal importance.

No sugar producing country is without its own peculiar problems, which although very different from the United States, are just as difficult to solve, and the most successful ones in the future will be those which give the greatest attention to the systematic and intelligent study of the factors limiting production.

The total cost of manual labour necessary to produce the cane and deliver it to the factory is the largest single item of expense, and during 1922 reached 42 to 47 per cent. for plant cane and 53 to 58 per cent. for stubble. In a plantation with one quarter each of fall and spring planting and one-half stubble, the manual labour thus accounts for 48 to 52 per cent. of the cost. The cost of growing and harvesting a ton of cane, exclusive of overhead charges and interest on investment in land, was calculated for about 4,000 acres selected from individual plantations as typical of the 1922 crop; and came to $ 5·32 for all planting, $ 6·18 for spring planting, and $ 4·42 for stubble, with a weighted average of $ 5·08. These figures extracted from the various data should present the means of forming some idea as to costing in either parts of the world as compared with Louisiana. The Committee say that with heavy labour charges and the great outlays on the factories, railways and communications generally, cane sugar manufacture must be operated with the highest possible efficiency, both in the field administration and factory methods. But it may also be suggested that, but for a large measure of protection, open competition would involve the industry in considerable difficulties.

PADDY.

SOME TRIALS WITH SELECTED SEED PADDY IN HARISPATTU.

W. MOLEGODE,

Agricultural Instructor.

During Maha season of 1922 a quantity of pure line seed paddy labelled B 12 Type, and since come to be known among cultivators as Peradeniya Hatiel, was supplied for trial by the Department of Agriculture and was tried at Katugastota on ½ acre of land in the Kondedeniya range of paddy fields. The trial was made on a field belonging to a villager and the cultivation was carried out by the owner himself. At first there was great reluctance on his part to "experiment" with an entirely unknown variety of seed paddy. But on giving an undertaking to recompense any loss he may sustain he consented to grow the paddy. The results turned out to be very good and in that year this paddy gave a crop quite 25% more than the village paddies.

It did not take long for the cultivators of the adjoining fields in the locality to realise that the paddy was not a foreign and doubtful variety but was exactly similar in its habits to the local Hatiel except that it tillered, bushed out and yielded better results.

In the Maha season of 1923 the extent under this paddy was increased to 4 acres. Though an unfortunate swelling of irrigation channels and bursting of bunds destroyed and damaged a very considerable portion of the growing paddy, the ultimate results of this season's trials showed that the paddy gave even better results than last year and compared most favourably with local paddies as the following tabulated statement would show:

Name of Paddy	Date Sown	Date Harvested	Extent Approx.	Yield in Bushels	Fold	Yield per Acre
B 12 (Peradeniya Hatiel)	3-9-1923	11-3-1924	¼ acre	15	30	60 bushels
Molegode Hatiel	5-9-1923	12-3-1924	do	12½	25	50 ..
Village Hatiel	9-9-1923	13-3-1924	do	8	16	32 ..
Molegode Hatiel	9-9-1923	13-3-1924	do	11	22	44 ..

Owing to heavy silting and damage already referred to, the rest of the area cultivated with this paddy remained in patches and therefore statistics were not collected. But it was quite clear from what was left that the paddy

tillered most beautifully and there were instances where 35 and 40 well filled earheads were counted in each bush as against 10 to 12 in local varieties. The growth and tillering habits and the heavy earheads attracted the attention of cultivators, so much so that before the harvest in March, 1924, there were many more cultivators anxious to secure seed of this paddy. All applications for seed were not, however, met as the writer decided to release this paddy for extensive and wide-spread cultivation gradually; for, from experience it has been found that if any new variety of paddy fails, even owing to the mistakes on the part of the cultivator, that paddy carries a reputation which is not easily removed.

In the Maha season of 1924, however, the extent under this paddy was increased to 8 acres in its "original home," *i.e.*, Kondedeniya and two further centres for "trial" cultivation were selected, viz., Ranavana and Dunuwila villages, also in Harispattu. From the following figures pertaining to this season's crop it will be seen that the results are once again convincing and, judging from the decisions of the cultivators in these villages to grow this paddy more largely next Maha season, there can be no doubt that they themselves are perfectly satisfied of the Peradeniya Hatiel as a heavy yielding paddy.

1924-1925 Maha.

Centre	Date Transplanted	Date Harvested	Extent Approx.	Yield in Bushels	Fold	Yield per acre
Kondedeniya	5-10-1924	2-3-1925	¼ acre	18	36	72 bushels
Kondedeniya	7-10-1924	3-3-1925	3/10 ,,	23	38½	76 2/3 ,,
Kondedeniya	12-10-1924	6-3-1925	½ ,,	35	35	70 ,,
Kondedeniya	Broadcasted 28-8-1925	10-3-1925	2 ,,	124½	31	62¼ ,,
Ranavana	13-9-1925	18-3-1925	½ ,,	28½	28½	57 ,,
Dunuwila	18-9-1925	21-3-1925	½ ,,	26 2/5	26	52 4/5 ,,
Kondedeniya	6-9-1925	22-3-1925	1 ,,	56	28	56 ,,

Two other items of interest concerning this variety of paddy may be mentioned. (1) That at the Kandy Agri-Horticultural and Industrial Exhibition of 1923 this paddy won the Silver Medal for the best sample of Maha paddy—the Judges having been confronted with the difficulty of selecting between four exhibits of equal merit from appearance acceded to the suggestions to weigh the paddy and it was found that this paddy weighed 48 pounds per bushel as against 42, and 43 pounds the other paddy. (2) At the same Show in 1924 the prize for the best paddy earhead was awarded to this paddy. A rather tedious nevertheless an interesting suggestion was made to count the grains of these earheads from each exhibit and the first three exhibits showed an average of 286 grains in this paddy, 211 in the next best and 188 in the third respectively.

DAIRYING.

THE IMPORTANCE OF THE DEVELOPMENT OF THE DAIRY INDUSTRY IN INDIA.

WILLIAM SMITH

Imperial Dairy Expert in India.

The dairy industry in India at the present moment is probably in a more backward and undeveloped state than in any other civilized country in the world. In the large cities of India to-day, the price of pure milk is 100 per cent. higher than it is in New York and Chicago and in many parts of India it is impossible to procure reasonably pure and clean milk at any price. The great majority of Indian inhabitants do not eat animal food of any kind, excepting milk and milk products, and the health and physical well-being of the nation demands improved methods of milk production, handling, and sale. India imports large quantities of condensed milk, dried milk, milk sugar, and tinned milk foods of various sorts, all of which she should herself manufacture, but up to the present there is not even a single modern milk pasteurizing plant at work in this country.

INDIA'S PROBLEM.

The broad problem lying at the root of progress in India may be said to be the increase of the wealth earning power of the masses, and the insuring of the benefits of this increased wealth to those who earn it, or, in other words, the increase in the wealth-producing capacity of the man in the field, and the prevention of the grabbing of this increase by parasitical classes, who do not help to earn it. India is mainly an agricultural country, and to advance its real prosperity not only must the wealth-earning capacity of the cultivator be increased, but the productive capacity of the soil must be enlarged and the agricultural resources of the country developed.

I know of no sphere of agricultural development which offers such a promising field in this direction as the development of the great dairying industry, because, as I hope to show later, the progress or otherwise of this industry very seriously affects the greatest of all agricultural problems in this country—the cattle-breeding problem. The wisest of eastern monarchs has left it on record that "much increase is due to the strength of the ox" and this 3,000-year-old maxim may be taken as doubly applicable to India to-day. Every agricultural operation in this country, right up to and including the transport of produce to the rail, is dependent on the strength of the ox, and it follows that every addition we can make to the strength and efficiency of this animal is a direct increase to the wealth of the country, and if we can eliminate the money lender there will be a corresponding advance in the standard of living of the man who owns and works the ox.

DECLINE OF STOCK.

It is my opinion, based on 18 years' close contact with cattle-breeding in all parts of the country, that the strength of the ox is decreasing in India, and that the country to-day does not breed the same quality of milk and draft stock it produced 12 to 14 years ago. This is due to a variety of causes, but principally, I believe, to the conserving of many of the old cattle-breeding jungles as forest reserves, and the spread of the canal irrigation system, thereby converting what were formerly cattle-breeding jungles into grain-producing areas. If this be so, and I think the fact is generally admitted by those who have studied the subject, then there is only one remedy, which every other country has had to adopt when it met a like problem, viz., the cattle must be bred on the cultivated lands. This can only be done, and will only be done, when it is economically sound for the cultivator to breed and rear cattle, and it is in order to make the breeding of cattle a payable proposition that the dairy industry must be developed.

BREEDING GOOD DRAFT ANIMALS.

I have heard it stated by those in authority in India that you cannot produce a good class of draft bullock out of a first-class milch cow. My experience does not confirm this; rather, I maintain that you cannot possibly produce the very best class of draft bullock out of anything but a really good milking cow. The ability to produce milk, Nature's all suitable food for the young, is the strongest and best proof of maternity and the more efficient and perfect the dam, the more vigorous and healthy the offspring. The quality of yielding milk in no way clashes with draft points, and it can be proved that not only is there no antagonism between first-class draft qualities and the giving of milk, but they are identical, and in many parts of the world where oxen are used for tilling the soil the male offspring of the heavy milking breeds have been found satisfactory for this purpose. If, therefore, from the same dam we can produce the best draft cattle of any type required, from the heavy milkers of that particular type, it follows that the primary essential for successful cattle-breeding in India is the development of the dairy industry. To make it economically advantageous for the cultivator or the grazier to breed and rear cattle, they must first obtain and breed from the profitable milch cow. Not only so, but given the good milker, the income of the breeder must be assured from both sides; *i.e.*, the technical business part of the dairying industry must be developed so that the cow owner may manufacture and sell to advantage the milk or milk products from his cow as well as the male progeny which will become the draft animals of the future.

DEVELOPMENT OF DAIRYING.

It is in connection with the development of the technical and business side of dairying that the most successful results have been obtained in the application of co-operative methods to productive agriculture. In most countries of the world which have a peasantry who cultivate their own lands, the manufacturing and distributing side of the dairy industry is done on co-operative lines, and the result has been that not only do the small cow owners reap the whole of the benefits of their industry, but the educative and moral effect of co-operative association in this class of

business has been of great value in teaching the small farmers business methods, the value of combination, and in time eliminating the usurer. I know of no reason why the same results should not follow the development of co-operative dairying in India, and if by means of co-operative dairying, the Sowcar or Combeen man of the East can be eliminated and the actual producer get the great part of the fruits of his labour, this is in itself a strong reason for the necessity of the advancement of the industry in India.

As things are now, in many cases the cow is useless for anything but dropping a male calf, and as it may be assumed that half of the animals born yearly will be males and half females, the greater part of the female stock born are an incubus on the land and, in breeding parlance, "eat their heads off." In short, as cattle-breeding in India must in the future be done by the cultivator, it cannot be made really profitable outside of the dual-purpose cow, producing milk in the case of the female and efficient draft qualities in the case of the male. No other system is practicable, as heifers not required for breeding cannot be sold for beef in India, nor can they in many cases be killed off as useless. In districts where male buffalos are suitable for draft the same argument applies.

Every agricultural operation in India depends to some extent on the efficiency of the draft ox. This efficiency can only be increased and secured by the development and the fostering of breeding on dual-purpose lines: *i e.*, dairying draft. From this point of view the development of dairying in India is of paramount importance, but there are other important reasons why the dairy industry in this country must be fostered, and of these I propose to touch on two only, viz., (1) the necessity for a cheap and plentiful supply of dairy produce as a food of the people, and (2) the value of dairying as a means of maintaining the fertility of the soil where general farming is practised.

PURE MILK NEEDED.

(1) India is a vegetarian country, the people generally do not eat meat, and I do not think there is anything which can take the place of ghee and the various products made from milk, either evaporated or curdled, as wholesome, strengthening, and easily assimilated foods for the people, to say nothing of the absolute necessity for fresh milk for children and aged and infirm persons. The children of the nation are the hope of the future, and in these modern days, when the mother is so often unable to suckle her offspring, a cheap, pure and plentiful milk supply will go a long way to reduce the heavy infant mortality in cities and large villages. At the present time in most large cities and many Indian villages, pure milk is a luxury of the rich, whereas it ought to be the common food of the poor. From the point of view of the health of the people at large and their food supply generally, the importance of the development of the dairying industry in India cannot be overstated. There is no nation in the world whose people appreciate the product of the cow so much as the people of India, and yet to-day Indian cows generally are 100 per cent. less efficient as milk producers than those of most civilized countries. That they can in time be made more efficient is a certainty, and it is a truism that the efficiency of the dairy cows of any country is a true indication of the general agricultural advancement of that country.

POVERTY OF THE SOIL.

(2) The problem in front of the agriculturist in India, especially in the irrigated areas where failure of rainfall does not enforce frequent fallow years, is how to best restore the nitrogen, potash, and phosphates to the soil which the crops have removed, and there is no doubt that the development of dairying amongst the cultivators would, to a large extent, solve this problem. The land suffers in India from the want of what may be classed as mixed farming, and until the man who tills the soil gets into the habit of rearing and keeping cattle on his land, which can only be profitably done on dairying lines, there is no hope of his adequately manuring the land. If every cultivator fed a large part of the fodder grown on his land and a small part of the grain he produced to cattle, housed on the land, the manure from the cattle, if carefully husbanded and scientifically applied, would greatly enhance the general richness of the soil and increase its productive capacity. It may be said here that the practice of burning manure so common in India would prevent this, but this factor also can only be altered on economic lines, and I believe that the introduction of general dairying would go a long way to prove to the cultivator that the value of cowdung as a manure was in many cases greater than its fuel value, and in any case it would increase the quantity available so that an appreciable quantity would be left for manure after meeting fuel requirements.

CONCLUSIONS.

To sum up, from an agricultural point of view the development of the dairy industry in India is of the greatest importance, because —

(1) Only by this means can the greatest of all agricultural problems in India, the cattle-breeding problem, be placed on a sound economic basis.

(2) It particularly lends itself to development on co-operative lines; agricultural co-operation has been the business salvation of the small holder in many countries and it should be so in India.

(3) The solving of the cattle-breeding problem on dairying lines must at the same time enormously increase the productivity of the land, as the farmer will breed, rear, and feed his own animals on his own land, and their manure will be available to renew the fertility of the soil year by year.

From a general point of view, as apart from the purely agricultural aspect of the question, there remains the great and far-reaching effect of the development of this industry on the health of the common people. Cheap and pure dairy produce is essential to the health of the community; they cannot get it now, and nothing but the development of dairying as a national industry will give it to them.—The Planters' Journal and Agriculturist, Vol. I, No. 15.

ESSENTIALS OF GOOD MILKING.

The essentials of good milking (points out a publication of the English Ministry of Agriculture) are that it should be performed quietly (that is, with no discomfort to the cow), quickly (rapid milking appearing to increase the flow), and thoroughly—the last milk, being the richest, should always be withdrawn.

In the milkers' contest held at the London Dairy Show, in which no competitor is allowed to milk his own or his employer's cows, the following are the points upon which competitors are judged :—(1) Manner of approaching the animal, and style of work, 20 points; (2) cleanliness, 10 points; (3) clean stripping, 10 points; total 40 points.—Agricultural Gazette of N. S. W., Vol. XXXVI. Part 1.

PESTS AND DISEASES.

THE WORK OF THE IMPERIAL BUREAU OF MYCOLOGY.

E. J. BUTLER, C.I.E. D.Sc., M.B.,

Director.

The serious study of the depredations caused to cultivated crops by parasitic fungi and bacteria dates from comparatively recent times, and it was not until after the beginning of the present century that any organized attempt was made to ascertain the cause and seek methods of prevention of crop diseases in the tropical and sub-tropical parts of the Empire. As agricultural departments were established in the various dependencies, officers were appointed who were charged with the duty of investigating the diseases of plants and devising means for their prevention or control. These officers are usually termed "mycologists," though the names "plant pathologist" or "phytopathologist," used in other countries, more aptly describe their functions. There are not far short of 100 such experts at present at work in the overseas parts of the Empire, all, with very few exceptions, attached to Government Departments of Agriculture.

In some cases these workers enjoy facilities not inferior to those available in the best equipped laboratories and research stations in England. In others, and this applies particularly to the tropical areas, certain facilities are poor. The chief lacks in such cases are a good library and access to authentic specimens of the parasites known to cause disease in plants. There is nothing more discouraging than to find that work which has cost much time and labour has already been done somewhere else, or that a supposed new parasite has previously been studied and its ways are known. Even in the best equipped centres it is difficult to keep pace with the mass of research and practical work that is going on in many parts of the world, and to see and find time to read all the publications (many in obscure journals or difficult languages) that have a bearing on one's work.

In the past, assistance in such matters was provided by the Royal Botanic Gardens, Kew, and the British Museum of Natural History at South Kensington. Germany had carried the systematic study of the subject beyond the point reached by any other country, and German assistance was almost indispensable to the overseas worker. With the outbreak of war the inadequacy of these arrangements became painfully evident, and both in England and in the dependencies means were sought to satisfy the requirements of the scattered band of mycologists throughout the Empire. The Imperial Bureau of Mycology was the result.

The Bureau was founded in consequence of a resolution of the Imperial War Conference passed on July 8, 1918. The subject was brought to the notice of that body by the Colonial Office, which, impressed by the success which had attended the efforts of the Imperial Bureau of Entomology,

founded five years earlier to meet a similar situation in regard to insect pests, thought that the time had come to establish a like organization to deal with the other great class of destructive agencies in agriculture—namely, the diseases of plants caused by fungi. A number of the overseas Governments expressed their readiness to contribute to the support of the Bureau, and work was eventually started in September, 1920. The affairs of the Bureau are managed by an honorary committee appointed by the Secretary of State for the Colonies, with Earl Buxton, G.C.M.G., as Chairman. Its finances are on a temporary footing, and negotiations are in progress to extend them for a period of five years from April 1, 1925.

The work of the Bureau falls naturally into two main divisions: it serves as a clearing-house for information on all aspects of plant pathology other than those concerned with insects and the like, and it examines and reports on specimens sent in from all parts of the Empire.

As a centre for information the Bureau endeavours to keep in touch with the work on the diseases of plants going on throughout the world. A staff of linguists is engaged in reading all the literature on the subject published in any part of the world to which access can be had, and in making abstracts of all original papers. These abstracts are printed monthly in a journal published by the Bureau, the *Review of Applied Mycology*. They are given in sufficient detail to enable workers in many cases to dispense with reference to the original paper, and are issued sufficiently promptly to keep up a survey of current activities in the whole field of plant pathology. The monthly numbers at present contain from 100 to 120 abstracts, and the volume for 1924 runs to 752 pages, exclusive of the index. The latter is in great detail, as the value of an abstracting journal in after years depends on the readiness with which references to particular matters may be looked up. No attempt is made to secure a satisfactory balance-sheet in regard to the *Review*: to do so would be impossible without charging a prohibitive price per copy, as the circulation is practically limited to the comparatively few who are directly interested in the subject. Hence an appreciable proportion of the Government grants is applied to the production of the *Review*, and copies are supplied free of charge to all the contributing Governments for the needs of their departments. At the recent Imperial Mycological Conference, held in London last July, a resolution was passed expressing appreciation of the service rendered by the *Review* to all workers on the subject, especially those in the overseas parts of the Empire. It is probable that no branch of the work of the Bureau has been more widely approved than the publication of this journal, and its reception has been scarcely less cordial in America and on the Continent than within the Empire.

Another aspect of the information service is the furnishing to enquirers of references regarding previous work on a problem. In order to deal with such enquiries the Bureau aims at keeping up a comprehensive card index to the literature on plant diseases, and in addition, maintains a large lending library of original papers in pamphlet form available for issue on demand. This library numbers over 6,000 items, cross-indexed by subject and author, and is increasingly being made use of by overseas mycologists. Extracts and translations from publications not easily available are also asked for at times, and requests for information of one kind or another are received in

considerable numbers, almost by every mail. Recently a demand has arisen for copies of sections of the subject card index to be made available for some of the larger departments and these are being issued at cost price.

The examination of, and reporting on, specimens sent from overseas is the second main activity of the Bureau. Progress in this branch of mycology is less advanced than in regard to insects. The fungus flora of a great part of the British tropical and subtropical dependencies is not well known; an enormous amount of work remains to be done before an adequate account could be given of, say, the fungi of Tropical Africa. Plant disease surveys have been undertaken in some areas, but these are, as a rule, confined to recording the diseases which cause notable damage to important crops. Unfortunately, a parasite that may be inconspicuous and relatively harmless in one area may cause a major disease in another. Many years ago the writer collected an insignificant leaf-spotting fungus on cotton in Kashmir which proved to be new to science. Nothing more was heard of this until, in 1920, a severe outbreak of a new disease of cotton was reported from Arkansas, and on investigation was found to be due to the same fungus. How it got from Kashmir to Arkansas (or *vice versa*), and what countries in between it affects, are not known, but it is evident that every record of its distribution would be of importance.

Within the limits of the capacity of its small staff the Bureau tries to aid in gaining a more detailed knowledge of the fungi of the colonies. In some, such as Ceylon, little or no outside help is required, for such knowledge is already far advanced. In others, intensive collection is much needed, and it will be many years before the survey is completed. The number of systematic specialists available for the study of these collections in England is small, and progress is likely to be slow even with the aid of foreign workers.

In addition to this general systematic work a large amount of time is devoted to the examination of individual specimens, often of obscure diseases or of parasites whose identification is difficult. In regard to this part of the work the position of the Bureau is somewhat like that of a consulting physician, except that it does not aim at dealing with all such enquiries itself, but passes many of them on to other specialists. In every case the idea is to get the best advice available, whether in England or abroad. The organization of the information side of the work is called into service here, since it is through the latter that the Bureau keeps in touch with active workers in various parts the of world and is usually in a position to know at any given moment who are working on any disease or group of fungi that the specimen may belong to.

A couple of cases illustrating this branch of the work can be taken from enquiries regarding cotton diseases that have been dealt with during the past year or two. The outbreak of black arm disease, caused by *Bacterium malvacearum*, in the Sudan, is one of the serious problems which the Sudan Plantations Syndicate has to face. The Bureau has been in close touch throughout with Mr. R. E. Massey, the Sudan Government Botanist, in whose hands the investigation of this problem is placed. The first isolations of the parasite were sent to the Bureau to confirm its identity with *B. malvacearum*, and new cultures made from these were transmitted to Dr. Erwin Smith at Washington, the original describer of the parasite. He tested it fully, and reported that it was a variety of this organism, which was known also in the United States, but had not been described in detail. It is probable that without such an authoritative opinion there would still be doubt whether the disease was really black arm. Furthermore, the search for a satisfactory method of disinfecting the seed has been aided by the Bureau putting Mr. Massey in touch with institutions and firms most

likely to be of assistance to him. The recent promising trials of izal against the same disease in the West Indies were arranged entirely through the Bureau. The prevalence of black arm in Nigeria has just been reported to the Bureau, which is thus in a position to put the local mycologist in direct touch with practically all that is known about it elsewhere.

A second interesting case is concerned with an obscure fungus which has been known to attack cotton and other plants in India for a number of years. More recently Mr. Briton-James, the late Mycologist to the Ministry of Agriculture in Egypt, found a similar fungus injuring cotton in that country. Dr. Shaw of Pusa, India, suggested that the Bureau should compare the parasite with a fungus, *Sclerotium bataticola*, which attacks sweet potatos in the United States. Cultures of the Indian, Egyptian, and American fungi were grown side by side at the Bureau and proved to be indentical. The curious thing is that the fungus has not been reported on cotton in America, while in the other countries it has not been found on sweet potatos. Quite recently all three strains have been tested on sweet potatos in Uganda, and all were found to rot the tubers just as described in America. In Uganda the same fungus infects beans, and will doubtless be found on cotton too, while from Nigeria it has recently been received on cotton and ground-nuts.

It can easily be realized that a single enquiry of the nature of those mentioned above may occupy several months and involve, in such cases as the last, a good deal of laboratory research. Apart from this kind of work, however, the Bureau does no original research, since it has always maintained the view that research into the cause and control of plant diseases must be done on the spot.

While the Bureau, for obvious reasons, works as a rule through the local departments of agriculture, its services are freely available to non-official mycologists. These are fortunately few as yet, but the example set by the Indian Tea Association, the Rubber Growers' Association, and a few large corporations such as the Colonial Sugar Refining Company in Australia, in maintaining their own research staffs (including mycologists), is worthy of wider imitation. The existence of the central organization outlined above will undoubtedly make such a policy easier to adopt, and will smooth the path of the individual workers in small, isolated scientific centres, such as one may hope will be founded in increasing numbers by the plantation industries in the overseas parts of the Empire.—The Empire Cotton Growing Review, Vol.II. No. 1

OIDIUM LEAF-FALL OF RUBBER.

The following extract is taken from the Report of the Botanist and Mycologist for the quarter ending March 31st, 1925:—

There has been an abnormal fall of young *Hevea* leaves this year after wintering. A species of Oidium has been found associated with this leaf-fall. This disease has previously been reported from Java, but this is the first time it has been found in Ceylon. Its occurrence this year does not appear to be restricted to definite localities. In the Kandy District it was fairly common; specimens have also been received from the Kegalle district, Rangalla and Bentota. The Mycologist of the Rubber Research Scheme has been informed of the presence of Oidium on the fallen leaves and the fungus was shown to him during his visit to Peradeniya.

IMPORTED BENEFICIAL INSECT.

The following extract is taken from the Progress Report of the Government Entomologist for the 1st Quarter, 1925:—

Towards the end of 1924 a consignment of the cochineal scale insect (*Dactylopius tomentosus*) was received from Australia on cactus (*Opuntia dillenii*) with the object of trying to get this enemy of the cactus, or prickly pear, established under field conditions to control the cactus pest in the Trincomalee district.

We have been able to breed up sufficient material of Dactylopius to send a small consignment to the Director of Irrigation, Trincomalee, about the middle of March for trial on the cactus in that district. The results of this experiment are being awaited with interest. It is hoped to have a further small consignment of Dactylopius available for distribution to the island of Delft at an early date.

POISONING GREEN TIMBER WITH SODIUM ARSENITE.

Ordinary ringbarking is effective if done at the right time for the particular district, for it must be conceded that seasons vary considerably from year to year, making the operation an adjustable one. But ordinary ringbarking has one disadvantage—it is slow, often taking twelve or eighteen months before the trees can be burnt off.

Of late years, the action of arsenic has been introduced with marked success in hastening the killing by the ringbarking process, and trees that ordinarily take months to kill by the old method, are now killed in a few weeks, and frequently in a few days, by the application of arsenic.

The time to carry out the work of poisoning is when the tree is dormant —that is, when the sap movement is at its minimum and the sap right down in the roots and lower portions of the trunk. This occurs in the months of, say, March to July, according to the district. The main object in catching the sap to season is to prevent suckering. Trees can be killed by arsenic or ringbarking at practically any time of the year, but to prevent this suckering it is highly important to operate when the sap is down, or just completing its downward course.—Queensland Agricultural Journal, Vol. XXIII, Part 3.

TO CONTROL CABBAGE MOTH.

W. B. GURNEY,

Government Entomologist.

To keep cabbage plants free of cabbage moth (*Plutella maculipennis*) persistent spraying in the seed-beds, and later in the field, with kerosene emulsion or tobacco wash is useful. Experiments at Bathurst Experiment Farm, however, have shown that "Georgia mixture" is the most satisfactory spray to use. To make this mixture add 2 lb. of arsenate of lead to 50 gallons of water, and to this solution add one-sixth of a pint of a solution made up of 1 lb. resin and ½ lb. fresh washing soda boiled in a quart of water until a clear brown liquid is obtained. This mixture can be sprayed up to within five weeks of using the vegetables.—Agricultural Gazette, N. S. W., Vol. XXXV. Part 5.

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CEYLON AGRICULTURE.

BOARD OF AGRICULTURE.

Minutes of a Meeting of the Board of Agriculture held at the New Chemical Laboratory, Peradeniya, at 9 a. m. on Thursday, March 12, 1925.

His Excellency the Governor presided.

Present:—The Director of Agriculture, Sir H. Marcus Fernando, Hon. Lt.-Col. T. Y. Wright, Messrs. Graham Pandittasekera, T. Walloopillai, C. E. A. Dias, J. W. Oldfield, Allan Coombe, Hon. Mr. W. L. Kindersley, Government Agent, Central Province, Gate Mudaliyar A. E. Rajapakse, Messrs. N. D. S. Silva, C. C. du Pre Moore, C B. Loudon Shand, T. A. de Mel, Acting Manager, Experiment Station, Peradeniya, Economic Botanist, Divisional Agricultural Officer, Southern, Entomologist, Botanist and Mycologist, Messrs. Alexander Bruce, A. A. Wickramasinghe, John Horsfall, T. J. Wilson, R. G. Coombe, E. W. Keith, Wace de Niese, R. Senior-White and A. W. R. Joachim (Secretary).

Visitors:—Messrs. A. R. Westrop, H. A. Webb, A. H. Van der Straaten, Jos. M. Malcolmson, N. K. Jardine, W. G. Scott, P. R. Shand, G. C. Slater, F. R. Senanayake, F. P. Jepson, Malcolm Park, C. H. Gadd, Huntley Wilkinson.

Letters and telegrams regretting inability to attend the meeting were received from the following gentlemen:—Hon. Mr. James Peiris, Messrs.

Geo. Brown, S. P. Blackmore, H. B. Daniell, A. F. B. Smeaton, F. J. Smith, L. A. Dassanayake, M. Ramalingam, Hon. the Controller of Revenue, Messrs. C. W. Bibile, G. A. Gunatillake, S. Muttutamby and W. A. Amarasekera.

The Minutes of the previous meeting held on March 13, 1924, were taken as read and confirmed.

Before proceeding with the business of the day, the Director of Agriculture announced the deaths of the following members since the last meeting of the Board:—Messrs. J. Graeme Sinclair, M. Kelway Bamber, A. W. Beven and H. W. Gavin.

The Chairman made a few comments referring to the loss sustained by the Board by their deaths.

Agenda Item No. 2 — Opening of Chemical Laboratory by His Excellency the Governor.

The Hon. Mr. F. A. Stockdale in requesting His Excellency the Governor to open the Laboratory dealt with the importance of Agricultural Chemistry in the advancement of our knowledge of the science and practice of agriculture. He also made reference to the valuable work done by the late Mr. M. Kelway Bamber to whom Ceylon owed a great deal for the valuable information it possessed on the manuring of tea and rubber and the use of green manures. His Excellency followed with an interesting and eloquent address in which he emphasized the work being done by the Department of Agriculture. He also expressed satisfaction that he had, true to the promise he made when he first arrived in Ceylon, done everything in his power for the advancement of Ceylon Agriculture.

Lt.-Col. T. Y. Wright and Sir H. Marcus Fernando also spoke and thanked His Excellency the Governor for the great interest he had taken in developing the agriculture of the country.

Agenda Item No. 3 — Inspection of the Work of the Mycological and Entomological Divisions of the Department.

His Excellency accompanied by the Director of Agriculture and Officers of the Department of Agriculture then made an inspection of the work of the Mycological and Entomological Divisions and was greatly impressed with the research work that was carried on in these Laboratories.

Agenda Item No. 4 — Inspection of Experiment Station, Peradeniya.

As the weather turned out to be very wet the inspection of the Experiment Station, Peradeniya, had to be abandoned. Only the cover-crop plots were inspected.

Agenda Item No. 5 — Report on Work on Paddy Selection by the Economic Botanist.

The Hon. Mr. F. A. Stockdale, Director of Agriculture, presided at a short meeting held at the Experiment Station, Peradeniya, at which Mr. R. O. Iliffe, Economic Botanist, read a report on the work of paddy selection. He outlined the various methods of paddy selection that had been adopted and the results he had obtained thereby. He urged that permanent and beneficial results could only be obtained by the establishment of several Paddy Experiment Stations where experiments in seed selection could be tried.

Mr. C. E. A. Dias proposed a vote of thanks to Mr. Iliffe and it was seconded by Mr. N. D. S. Silva.

A suggestion was made that the work of the Economic Botanist should be brought to the notice of the Unofficial Members of the Legislative Council, particularly as funds would be required in the next Budget for additional paddy stations.

A. W. R. JOACHIM.
Secretary,
Board of Agriculture.

FOOD PRODUCTION COMMITTEE, COLOMBO DISTRICT.

Minutes of a meeting of the Food Production Committee of the Colombo District held at the Colombo Kachcheri, on the 21st March, 1925, at 11 a.m.

Present.—The Government Agent, Western Province (in the Chair), Mr. D. C. Senanayake, Mudaliyars D. C. R. Wijesinghe, G. W. Fonseka, F. T. Abayakoon, A. E. Abeyratne, L. A. Dassenaike (Gate Mudaliyar), C. H. A. Samarakkody (Gate Mudaliyar), J. P. Obeysekere, D. E. Wijesekere, and the Atapattu Mudaliyar, who acted as Secretary.

Minutes of the previous meeting were read and confirmed.

Considered the best method of expending the sum of Rs. 400/- allotted to the Hon. the Government Agent, W. P., from the vote of the Agricultural Department for Shows and Competitions.

Decided to utilise the whole vote in Prizes, to be awarded for Plantains with a view to encouraging Plantain Cultivation. The Competitions are to be held in the last week of August in each Korale, there being 3 prizes in each case, viz :—

Rs. 25/-	1st	Prize
Rs. 15/-	2nd	Prize
Rs. 10/-	3rd	Prize

Mudaliyars should appoint judges, and bunches for competition should be brought to one centre. Headmen should certify that each bunch entered for competition has been genuinely grown by the Competitor.

Resolved to ask the Director of Agriculture for suggestions as to th conditions for a Plantain Competition, to be held next year.

Mudaliyar Alutkuru Korale North announced that he is organising a Home Garden Competition among the school children of his Korale. He made no application for funds. Decided that a report on the competition be invited with a view to extending the idea, next year, if the competition proved a success.

Mudaliyar Salpiti Korale informed that he was organising a Show to be held at Piliyandala in August, 1925. It was to be financed by private subscription, but he would be glad to receive assistance from funds available to the Government Agent.

Resolved that a sum not exceeding Rs. 200/- be allowed from the Funds of the Colombo Agri-Horticultural Society in charge of the Government Agent, according as financial assistance should become necessary.

Read letter from Mr. Bentley Buckle suggesting the encouragement of Papaw cultivation. Resolved that no action was called for at the present in this connection. It was pointed out that the cultivation of the fruit with a view to collection of Latex, did not fall within Food Production.

The meeting closed with a vote of thanks to the Chair.

CO-OPERATION.

CO-OPERATIVE MARKETING AS A FACTOR IN IMPROVING OUR AGRICULTURAL CONDITIONS.

JOSE S. CAMUS.

Acting Chief, Agricultural Extension Division.

While every effort is exerted in developing our agriculture by increasing our production, the writer believes that the desired result cannot be obtained unless the farmers learn the methods of handling their products properly for the market through systematic co-operative marketing. A good farmer must not only know the best methods of farming; such as the proper preparation of the land, seed selection, crop rotation, the control and eradication of pests and diseases, but must also know the standardization of his products, as well as its proper packing and shipping before putting them on the market so that they may command a good price.

Our farmers to-day do not receive the full money value of their crops and find farming unprofitable for lack of systematic co-operative marketing. The introduction of this system into our farming activities would improve our agriculture in general, and would save our farmers from the usurers and speculators. Some farmers, especially those living in distant provinces, plant crops that will only supply home demand because they find it unprofitable to plant them in a large scale for lack of a good market, and, if there is any market at all, the price will not cover the cost of production and transportation. The marketing expenses, however, can be minimized if the farmers will only group themselves and sell together their farm produce at regulated prices.

Thus, while it is important that our farming methods should be developed, it is equally necessary that the marketing side be improved in order that the farmers may get the full money value of their crops.

Although the organization for co-operative marketing is comparatively recent in the Philippines, there is no doubt that it can be carried out here successfully as in other countries. It may take time, however, before good results can be obtained but it will not take long before our farmers will see its value.

CO-OPERATIVE ORGANIZATIONS ABROAD.

The first agricultural co-operative organization formed was in Denmark, organized in the year 1860, with the object of improving the live-stock and grain industry in that country. That organization, though of a different type from that of the present agricultural co-operative organizations, served its purpose, for the interest of the farmers was better taken care of and a great deal of work was done in improving farm seeds by producing better strains of plants and making these improved seeds available to the members of the society. Originally, it was composed of small farmers but later on the big wealthy landowners in Denmark joined the organization when they realized

the value of co-operation in solving their agricultural problems. Because of this movement much was accomplished in increasing production and in suppressing monopolies which existed in that country.

The work of developing agriculture through co-operative work among the farmers is being done more or less successfully in almost every country in Europe, in India, and in the United States. In the countries mentioned above there are but a few co-operative producers' associations at present that can be considered really successful. It was only in 1895 that the agricultural co-operative organization became an important factor in the United States in improving agriculture. One of the earliest co-operative marketing associations organized in that country was the Cranbery Growers' Association of New Jersey and Massachusetts. This association was not wholly co-operative as the product was sold separately and the returns were made to each member, on the basis of the sale of his individual crop. The products were sold under the brand of the individual grower and not of the association. After a few years this method proved to be wholly unsatisfactory, and so the members decided to form a central agency, known as the National Fruit Company, which handled all the products of the members under the company's name.

At present the most successful work in co-operative marketing in the United States is found on the Pacific Coast among the fruit growers of California, Washington, and Oregon. At the beginning the farmers found out that the method of marketing their crop was a very complex business because of the nature of the fruits, which is perishable. It was then impossible to distribute them to all parts of the United States and to export them to foreign countries. As the fruits produced varied in quality, the association took charge of standardizing the fruits handled and of packing and shipping them. By this process, grade and quality of the produce were assured and the association established a reputation. Later on a number of these local associations of growers grouped themselves into a central organization to handle their business on a more extensive scale. These organizations helped materially and were responsible for the success of the fruit industry in the United States to-day.

In 1914, an agricultural marketing society was organized in Burma to sell rice and pea-nuts direct to the wholesale dealers in Rangoon. The exporters protested to the Government of India claiming that the organized co-operative society had raised the prices of the products and as a result the merchants and consumers suffered. The committee assigned to investigate could not find any evidence to support the merchants' charges and the Government did not take further action. Due to the organization, unnecessary middlemen were eliminated and a better understanding between the wholesale dealers and the producers in India was established.

CO-OPERATIVE ORGANIZATIONS IN THE PHILIPPINES.

In the Philippines co-operation in various forms is part of the scheme of the work of our farmers, yet no efficient systematic organization on co-operative marketing was ever attempted until 1913 when work in this direction was started by the Bureau of Agriculture. Before this work was begun, the Director of Agriculture sent out letters to all provincial governors to find out what has been done along this line. From the replies

received it appeared that no organization of this kind existed in the Islands except two of a quasi-co-operative character found in Bulacan Province, one operating a rice mill and another operating a rice-threshing machine. The Societies were both composed of farmers who put up these machines for milling their own rice and those of others, charging some money or palay for milling.

Another association found was the Davao Planters' Association organized to foster and stimulate the cultivation of hemp in that province and to defend the interests of its members.

In July, 1914, an office of co operative organization was created in the Bureau of Agriculture to induce the farmers to group together in order to better their conditions, and to pave the way for the solution of their marketing problems.

Ex-Vice-Governor Martin during his administration started the movement. The initial work done was the organization of municipal and provincial agricultural societies. It was planned to have insular and provincial agricultural councils to look after the staple products such as abaca, tobacco, coconut, sugar and rice, and to organize the farmers according to their products. It was expected that through the organization of these co-operative agricultural societies the products of the members could be marketed co-operatively.

The support of the provincial and municipal authorities, the Constabulary and the schools, were secured in fostering this plan, and as a result there were 200 municipal agricultural societies organized by the Bureau of Agriculture in 22 provinces with a total membership of 15,000 in 1914 and a total of 286 municipal agricultural societies in 29 provinces at the close of 1918.

Of these associations but a few succeeded to come up to expectations. Among the municipal agricultural societies organized, the one in Pangil, Laguna, which has conducted co-operative marketing successfully is worth mentioning. This society started with small capital and gradually built up a fund amounting to ₱1,100. The members started the enterprise by buying the coconuts produced by the members and sold them direct to the wholesale dealers in Manila Other societies which attained a similar success are the municipal agricultural society in Lumbang, Laguna and that in San Antonio, Zambales.

CHAMBERS OF AGRICULTURE.

In 1922 at the convention held in Manila during the Carnival by the provincial governors, the presidents of the Agricultural Congress and of the Philippine Chamber of Agriculture, and the Secretary of Agriculture and Natural Resources, it was agreed upon to organize in the provinces, provincial and municipal chambers of agriculture in order to develop among the farmers a simple co operative system of buying and selling their products and placing them on the market with the least possible intervention of the middlemen and the speculators.

PRODUCERS' ASSOCIATIONS.

This plan was carried out in some provinces but the results obtained were not promising and so in April, 1922, another campaign was started to organize producers' co-operative marketing organizations composed of

farmers producing the same kind of crop only such as banana planters, vegetable raisers, poultry raisers, mango growers, tobacco producers, milk producers, etc. This plan was considered better than the previous ones for as the members produce the same kind of crops the association can handle the business better and the members will have one common interest.

At the start many difficulties were encountered in organizing these producers' associations, and pessimism prevailed in some quarters because of the sad experiences of the people due to the mismanagement and abuse committed by officers and other members of previous organizations. The middlemen capitalized these failures and opposed the new organization, but in spite of these difficulties, thirty local co-operative producers' associations were organized in 1923 by the Bureau of Agriculture.

Efforts were also made by the Bureau of Agriculture to enable these associations to market their products direct to Manila. To start with, a central milk agency was established in the city which handled the products of four milk producers' associations in the provinces. Later on the Rizal Farm Mercantile Co-operative Association of Caloocan, Rizal, has also established an agency in Manila. Another milk agency was established in San Fernando, Pampanga, by the Pampanga Milk Producers' Association where milk prepared in a sanitary way was handled locally in a commercial scale.

The products of the Banana and Papaya Growers' Associations, however, were sold to the Manila Fruit Company and the National Fruit Company established in the city, as well as to other dealers.

The only Tobacco Co-operative Producers' Association so far organized by the Bureau of Agriculture is the one in Nemmatan, Jones, Isabela. This association will handle the tobacco crop of its members. The adoption of better methods of culture and better handling of tobacco are among the helpful activities of the association.

The Bureau of Commerce and Industry is also working along this line, and has so far, according to information, organized a tobacco association in Tuguegarao. With the combined efforts of these two bureaus and the co-operation of the Bureau of internal Revenue, more of these associations can be established in the Cagayan Valley which may be depended upon to solve the present tobacco problems.

Under the present method of marketing there is absolutely no incentive for the planters to produce better crop. The buying and selling of unstandardized products is not conducive to the production of better crop, as no better price is paid by the tobacco buyers for quality.

The tobacco crop passes through many hands before it reaches the manufacturer or exporter. As a consequence, the compensation of the intermediaries is added to the price of the product. Their elimination through co-operative marketing organization will, it is believed, redound to the benefit of the planters and the exporters, as the former will get the full value of their product, and the latter will pay a reduced price for the reason that they will not employ too many buyers as they do at the present time.

CONCLUSION.

There is no reason why co-operative marketing cannot be developed in this country as with the development of co-operative marketing the farmers will undoubtedly get better price and will be able to dispose of

their product more easily. They will also learn the standardization of the produce as to kind and quality; the proper distribution thereof to the market; the regulation of its supply and the proper method of selling and advertising, all of which are still not known to our farmers.

In the work of co-operative marketing three things can be demonstrated. First, agricultural co-operative marketing association creates a community spirit in any line they want to undertake; second, it serves as an important factor and as a medium in promoting agricultural interest in any province or municipality by increased production and by the standardization of products for the market; third, the success and failure of each association primarily depend upon the kind of management coupled with facilities.

Much has been said and written on the advantages of organizing co-operative associations with encouraging, instructive and convincing suggestions. People read and realize all these advantages, but when they are put into practice it is surprising to meet so many obstacles and difficulties in persuading farmers to engage on this profitable way of doing business.

A noted economist has said: "Of all the classes of society the farmers are the most easily divided, the most reluctant to stand together for their common defence and the promotion of their common interest."

So far as I have observed, the following are some of the obstacles which cause failures in co-operative marketing work in this country:

1. The ignornace of proper method of marketing the product as a limiting factor in the dissemination of the value of co-operative marketing organization.

2. The lack of business ability of the officers and frequent and systematic supervision and auditing of the accounts of the association.

3. The lack of economy as a cause of failures of co-operative organizations, especially those just starting. Oftentimes the officers forget to exercise all economy possible that what little income the association may gain is also lost. It is very essential for any young association that its expenses do not exceed the income.

4. The general weakness of the co-operative spirit and loyalty of the members to support the society. Every member exercises his individuality, feels independent and in cases where societies exist, the members do not look upon themselves in any other light than to throw his advantage and competition with each other in securing personal interest to the society.

5. *Opposition.*—The question of opposition is closely allied to that of loyalty; for while loyalty is maintained opposition is ineffective.—The Philippine Agricultural Review, Vol. XVII, No. 4.

THE COLOMBO DISTRICT CO-OPERATIVE UNION, LIMITED.

This Union, the first of its kind in Ceylon, has been started with the following objects:— (a) to develop and organize Co-operative Societies within the area of operations, (b) to provide a means of assessing and guaranteeing the credit of Co-operative Societies affiliated to the Union, (c) to control affiliated societies by careful and regular supervision, (d) to advise and assist affiliated societies to further their interests and (e) to diffuse knowledge on Co-operation.

GENERAL.

FORESTRY AND AGRICULTURE.

THE ALLOCATION OF LAND.

R. C. MARSHALL, M. A. (OXON.), DIP. FORS.

Conservator of Forests, Trinidad and Tobago.

Manwood, in his treatise on "The Lawes of the Forest," 1598, defines a forest as follows "A forest is a certain territory of woody grounds, fruitful pastures, privileged for wild beasts and fowls of forest chase, and warren to nest and abide in, in the safe protection of the King for his princely delight and pleasure, which territory of ground, so privileged, is meered and bounded with unremovable marks, meers and boundaries, either known by matter of record or else by prescription."

This definition with its pleasing old world flavour is, however hardly applicable to modern conditions and for the purpose of this article a forest may be treated as it is regarded in popular opinion, *i. e.*, as an area more or less (chiefly more) covered with trees. Inasmuch as forestry and agriculture are both based on the yield capacity of the soil, questions arise periodically as to whether certain areas should be allocated to forestry or to agriculture. A correct appreciation of the various factors governing the answer to the above question although, unfortunately, very often lacking, is of decided importance in affecting the welfare of the community. Instead of merely asking "is this land suitable for growing coffee, or sugar-cane, or cotton or tea or cacao, &c., &c.," a sounder policy would first dictate consideration of the question, "is this land more suitable for agriculture or forestry?" The utility of agriculture is so far more self-evident than the utility of forestry that the case for forestry often goes by default. Before proceeding further it is therefore well to examine briefly the various ways in which forests are of utility, both directly, through the production of timber and various other products, and indirectly, through the influence they exert on what may, somewhat generally, be described as climatic conditions. It is convenient to deal with the latter first.

THE INDIRECT UTILITY OF FORESTS.

Popularly, forests are supposed to increase very decidedly the rainfall and this question has been actively discussed for years past. The following evidence quoted from Schlich's *Manual of Forestry* Vol. I. (1922), is therefore of interest.

(1) Ebermayer's observations in Bavaria, started in 1867 and carried out with great care, do not justify any final conclusion as to an increase of the rainfall due to the action of forests. He states that in the plains the effect of forests is certainly very small, but that it increases with elevation.

(2) Extensive observations made in Sweden, on 400 stations during a period of 15 years, show that the difference between parts of the country with 56 per cent. of the land under forest and those with only 17 per cent. under forest is certainly not more than 3 per cent. increase in favour of the former.

(3) The Government of India has during late years investigated the subject, and the results obtained do not justify any direct conclusions beyond the fact that, if forests influence the rainfall at all, the effect is insignificant."

It would seem, therefore, as if yet another popular fallacy must be disclosed—many popular opinions, however, while erroneous as they stand, often contain a grain of truth and if for rainfall, be substituted "effective rainfall" the subject is changed to the conservation of water, on which forests have a profound effect It is also probable that whereas forests are the result and not the cause of rainfall, nevertheless various physical factors react towards rendering forests condensers of water vapour and thus producing small local precipitations.

The question cannot yet be considered as definitely closed. Having removed a claim for forestry which, though often made, is at least somewhat difficult to substantiate, it is now possible to consider briefly the effect of forest growth on factors which affect agricultural interests.

The temperature in forests is lower during the day and slightly higher during the night than on open ground, the mean annual temperature being slightly lower. This effect owing to constant interchange of air is communicated to the surrounding country, the effect of course varying with the distance and the extent of the forest. Observations too, have shown that the relative humidity of forest air is greater than that of air in the open, the effect being mainly due to temperature; near the 50th degree of northern latitude the increase was found to vary from about 5 per cent. in winter to 9 per cent. in summer.

The air being relatively somewhat moister and the temperature a little lower it follows that passing clouds would tend to have their moisture precipitated especially as the trees obstruct air movement. In this way local precipitation, referred to above, may be produced: on the other hand rain depends more on agencies such as the presence or otherwise of large shoots of water, mountain ranges, &c., by comparison with which the influence of the forest is but small. The relative humidity of the air being increased, it follows that evaporation from the soil tends to be less in and near to forests, than on open ground and thus on the whole it may be safely stated that forests preserve humidity to a considerable extent. Especially so is this true of mountain forests which from time immemorial have been regarded as the natural preservers of moisture.

To complete this brief survey of the indirect utility of forests it is necessary to refer to what may be termed the mechanical effect of forest growth—possibly its most important effect. A forest may be compared to a piece of blotting paper. If a drop of water is allowed to fall on a piece of blotting paper held at a slope the water will be absorbed; for the blotting paper substitute a piece of glossy paper and the water will run off. So it is with forested and bare land respectively. When heavy rain falls in the forest the mechanical force of the rain is largely broken by the trees and shrubs—so much so that in a dense forest most of the water reaches the soil either by dripping from the twigs and leaves or by running down the trunks of the trees. The surface soil in a forest consists of humus—decaying organic matter capable of absorbing large

quantities of water. It is, in fact, really a colossal vegetable sponge capable of holding many times its own weight of water. When rain falls it is absorbed by this sponge and gradually given off to the mineral soil beneath passing out eventually as springs which yield a steady source of supply to streams and rivers. If on the other hand the forest cover be injudiciously removed a very different state of affairs is liable to be set up. A tropical rainstorm falling on a comparatively bare hill-side instead of being absorbed can be the direct cause of floods, erosion and landslips. Referring again to the investigation which the Government of India instigated on the effect of forests on atmospheric and soil moisture it is important to note that the Government of India arrived at the conclusion that "the denudation of the soil, owing to the destruction of forests, might, as far as India is concerned, be looked upon as an established fact." The importance of this statement to the agriculturist is, perhaps, so obvious, that it has tended to be overlooked. The mountain forest is, in brief, the natural regulator of stream flow, both preventing floods and consequent erosion during the rains and, from the underground reservoirs providing a steady flow during the dry season. Once this fact is fully realised it is unecessary to labour certain obvious corellaries. It may not, however, be out of place to refer to the benefit of a pure and steady supply of drinking water such as is supplied by streams which rise and flow through forested country and also to the steady development of hydro-electric power which yearly is receiving more and more attention throughout the civilised world. So much for hill forests. Forests in the plains come under a different category, their value here being primarily as windbreaks. The protection afforded to agricultural crops by well located windbreaks is a question which might well receive more attention. Apart from windbreaks lessening damage from the mechanical force of the wind, the drying up of the soil is, on the whole, more influenced by wind than by sun and varies with the velocity of the wind. By a judicious arrangement of windbreaks conditions approximating to those which obtain in sheltered valleys may be brought about—an asset, the value of which is none the less real because it is difficult to reduce it to pounds, shillings and pence. Although the question of erosion has been dealt with very briefly it is, in practice, one of the worst evils resulting from unwise deforestation and the space devoted to this subject is no criterion of its importance; the action of the roots of trees in binding together the soil and preventing landslips and controlling shifting sands should also be noted. Having thus briefly reviewed some of the more outstanding indirect utilities of forestry it is possible to return to the question propounded at the commencement of this article, *i.e.*, the allocation of land to forestry or to agriculture. It is hoped that it is clear from the foregoing that, depending primarily on topographical considerations, there are certain areas which it is advisable should be retained under forests. Very often by their very nature, however, such forests are located in inaccessible places and it may often happen that, such being the case, they are not suited for the economic marketing of their various products.

THE DIRECT UTILITY OF FORESTS.

Forests produce timber (including pulpwood) and firewood as well as a variety of minor products such as barks for tanning, cork, turpentine,

various dyestuffs, gums, oils, &c.—incidentally in 1913 the import of these minor products into the United Kingdom was valued at over £27,000,000. Agriculture, normally, needs first consideration from the point of view of food production, but timber and firewood cannot he overlooked and provision must be made for them. In the past the forest resources of the world have been regarded as illimitable and it is only in recent years that investigations into the world stock of timber have shown that the position as regards timber supply is already serious and is likely to grow still more so. In other words the time has come, is in fact, overdue, when unchecked forest destruction must cease and more attention be paid to keeping certain areas under properly managed timber crops. Fortunately trees are, on the whole, far less exacting in their soil requirements than are agricultural crops and can be grown successfully on areas, which are really unsuitable for agriculture. On such areas, in fact, forestry is usually a more profitable undertaking than agriculture, *i.e.*, yields a higher net rental of the soil. In countries where forestry has reached beyond the forest protection stage and forests are properly managed, yield tables are available and from them it is possible to work out the average annual return which may be expected from an acre of forest land.

The necessary formula being as follows :—

$$\text{Soil rental} = \left\{ \frac{Yr + Ta \times l.op^{r-a} + \ldots\ldots + Tq \times l.op^{r-q} - c \times l.op^{r} E}{l.op^{r} - 1} \right\} \times op$$

where r = rotation
Yr = value of final yield
Ta = value of thinning at age a.
c = cost of formation
E = capitalised value of annual expenses
P = rate of interest.

The above formula may, for example, be assumed to work out at 18*s.* net an acre and unless at least this sum can be anticipated from agriculture it is clearly preferable to grow timber ; incidentally, a similar formula is made use of by the Forestry Commission in England. Many estates to-day have fields under agricultural crops to which they are quite unsuited and it is not too much to say that the attention which has to be devoted to these poor soil areas absorbs all the profits from the truly agricultural lands. Of course, accurate book-keeping and costing is necessary to determine doubtful points but in many cases a cursory examination of the soil (not only the surface but down to the depth of a few feet) will give the required information in a very obvious manner. There are thus various poor soil areas on which forestry is a sounder financial proposition than agriculture. It is, however, useless to expect such results unless a correct appreciation of certain fundamental principles of forestry be obtained. Although, on the whole, trees will thrive on soils on which agriculture is not profitable there is a big difference in the conditions and treatment which various species require—even as in England oak thrives on clay, while pines will flourish on a practically pure sand on which no other economic crop can be grown.

It is outside the scope of this article to elaborate such first principles as the difference between species which are light demanding and those which will bear shade, but a yield of about 3,000 cubic feet per acre after 50 years or so will not result if trees are merely planted and then left to find for themselves. On the other hand, if a plantation be formed either of a pure shade bearer or a mixture of a fast growing light demander with a slower growing shade bearer, trees spaced 4, 5, or 6 feet apart, as the case may be, and properly tended until the canopy be formed after a few years, then the plantation, to bring it to a profitable maturity, only requires periodic thinning—a matter, however, of great importance.

CONCLUSION.

An American publication dealing with the Forests of Porto Rico summarises very aptly many of the foregoing points in the following words: "Every acre of land around the head-waters and along the banks of rivers on which a forest cover would offer a protection superior to the present cover against erosion and soil wastage should be forested. All forested lands and those to be forested should be so managed as to yield a maximum of the products most needed by the local communities and industries. The forestry programme should also provide protection to the birds, live-stock, and even man himself in the form respectively, of small groves at intervals throughout the cane and tobacco districts, open cover in the pastures, and shade trees along the roadsides." (*U.S.A. Dept. of Agriculture Bulletin 354*),

Without agricultural development we cannot even maintain our present state of civilization: and forests, as has been shown, are often of the very greatest indirect assistance to agriculture. As for timber—we had better be without gold than without timber.—Tropical Agriculture, Vol. II. No. 4.

SPINNING TESTS OF CEYLON COTTON.

1924 CROP

Description of Sample	Total Waste, per Cent.	Nominal Counts	Strength at Nominal Counts	Product of Actual Strength x Count
Zulu Hybrid	25·7	77's	27·0	2,069
Durango	26·0	,,	27·3	2,112
Watts' Long Staple	30·2	,,	26·2	2,007
Extra Uppers (Control)	29·3	,,	25·2	1,882
Sea Island	24·2	95's	27·8	2,705
Zaga 310 (Control)	21·5	,,	30·8	2,773 Ideal=2,500

Note by the Chief of the Spinning Section in the Experimental Department of the Fine Cotton Spinners' Association.

"On being opened these samples were pulled and commented on as follows:

Durango	1 3/16 inches	medium fine; fairly strong
Zulu Hybrid	1 3/16 ,,	fine; strong
Watts' Long Staple	1 5/16 ,,	,, fairly strong
Sea Island	1⅝ ,,	,, strong

"They were considered good specimens, clean in handling and easy to work. There should be no difficulty in selling at a good price on appearance in bulk, the first two as Oldham qualities, the two latter for Bolton spinnings.

"It should be remembered that the Card waste is disproportionately high with small samples such as these, representing only a quarter of the normal stripping periods, and would drop considerably in normal working."

The three cottons—Zulu Hybrid, Durango, and Watts' Long Staple—gave satisfactory results when spun to 80's in comparison with Extra Uppers, the yarn strength of all three being slightly better, while the waste of Durango and Zulu Hybrid was considerably less.

The Sea Island was considered to be equivalent to an Extra Sakel, not fine enough to spin Sea Island counts. It was tested against the Super Sakel No. 310, and gave practically the same yarn strength, although it made more waste.—The Empire Cotton Growing Review, Vol. LL, No. 1.

CAPE GOOSEBERRY.

(*Physalis peruviana*).

The Cape Gooseberry may be grown in all but the coldest districts of the Union with a little care, and in view of its usefulness for jams and pies should be more extensively grown than is now done.

In the eastern districts of the Cape Province and eastern Transvaal, where large quantities of this fruit are grown, the growers have noticed that where the soil is rich in nitrogenous manures the plants go rank and produce little fruit. The soil requires liming every third or fourth year if continuous cropping is contemplated. The best results have been obtained from liberal dressings of stable and kraal manure, followed next year by a dressing of superphosphate at the rate of 400 lb. per acre, plus 150 lb. sulphate of potash, but no organic manures.

The seed should be sown in the same way as tomatos, *i.e.* in shallow trays, or in covered beds, and it is an advantage to get the plants started in August. Transplanting should be done from October to December to get the maximum yield in the winter. The plants commence to bear about May. The usual spacing of the plants is six or seven feet between the rows and three feet between the plants. When the plants overlay they gain support against the wind. There is no need to cultivate after the plants commence bearing; tall weeds should always be removed.

The ordinary Cape Gooseberry, planted six feet by three feet, should allow 2,420 plants per acre. The average yield per plant is two pounds (approximately), but under good conditions it may be higher. The maximum yield is obtained during June-July. The time of planting has some bearing on the producing period.

New plants should be set out each year, as the yield from the old stools gradually declines and the fruit gets smaller. As regards irrigation after the summer rains have finished (in the Transvaal), a great deal depends upon the depth of the soil and the care used in preparation. Where irrigation is necessary, seven feet spacing between the rows would minimize lateral damage through cultivating and drawing a furrow with a light plough. A native cannot always regulate the water in the furrow by using a hoe or a spade.

The Large Blue Gooseberry (*Physalis ixocarpa*) is a dwarf growing bush, and should be planted out four feet by four feet. The fruit is excellent for jams and preserves.—Journal of the Department of Agriculture, Union of South Africa, Vol. X. No. 3.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th APRIL, 1925.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1925	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	75	—	25	24	—	26
	Foot-and-mouth disease	849	376	746	1	101	1
	Anthrax	—	—	—	—	—	—
Colombo Municipality	Rinderpest	1	1				
	Foot-and mouth disease	274	23				
	Anthrax	—	—				
	Rabies	5	—				
Cattle Quarantine Station	Rinderpest	—	—				
	Foot-and-mouth disease	35	17				
	Anthrax	97	19				
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	255	7	255	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	9	2	—	9	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	130	102	98	—	32	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	14	—	14	—	—	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	394	—	394	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	95	12	78	11	6	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	441	19	437	—	4	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	937	26	865	33	39	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	112	42	24	62	—	26
	Foot-and-mouth disease	284	213	167	5	110	2
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	6	—	—	6	—	—

M. CRAWFORD,
Acting Government Veterinary Surgeon.

Colombo, 11th May, 1925.

METEOROLOGICAL

APRIL, 1925.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	82·0	—0·6	82	7·3	SW	92	15·95	14	+ 8·11
Puttalam	82·2	—0·6	80	3·6	SW	150	2·88	7	— 2·55
Mannar	85·7	+0·3	74	4·8	SE	178	2·82	5	+ 0·02
Jaffna	85·8	0	72	4·6	S W	260	0·66	1	— 1·27
Trincomalee	85·8	+0·6	71	4·3	S	149	0·45	5	— 1·53
Batticaloa	83·4	+0·2	79	3·4	NE	143	0·74	2	— 1·14
Hambantota	82·0	+0·1	82	4·2	SW	248	2·21	9	— 1·08
Galle	81·6	—0·2	84	5·2	W	152	11·83	18	+ 1·99
Ratnapura	82·4	0	78	6·2	—	—	7·51	21	— 4·90
Anu'pura	83·4	—0·2	76	5·1	—	—	11·92	11	+ 5·30
Kurunegala	82·5	—0·9	74	6·2	—	—	11·33	12	+ 1·96
Kandy	80·4	+1·4	74	6·4	—	—	8·12	11	+ 1·45
Badulla	75·3	—0·1	79	5·2	—	—	7·01	13	— 0·38
Diyatalawa	69·2	—0·3	76	5·9	—	—	7·42	17	+ 1·90
Hakgala	64·3	+2·0	80	5·8	—	—	7·00	14	0
N.' Eliya	59·8	—0·6	76	6·0	—	—	8·43	14	+ 2·83

April. The first week of this month was one of almost continuous fine weather throughout the island but from the ninth onwards the distribution of pressure was extremely uniform and gave rise to a succession of local thunderstorms. These were irregularly distributed until the 25th when a very mild gradient from the South-west was just strong enough to concentrate the bulk of the rain near the South-west coast with a temporary decrease in rain at inland stations.

The resulting total rainfall for the month was appreciably above average over a narrow strip of country near the west coast from Chilaw to Galle. At inland stations offsets occurred both above and below average but were in most cases small.

Sirikandura (Matugama) recorded 25·39 inches including 8·5 inches on the 16th while other falls of over 5 inches in a day were at Negombo, Chilaw, Hiyare (twice) and Passara.

Pressure was slightly above average in most cases and Humidity almost as consistently below. The mean wind velocity for the month was above average in all cases except Colombo. The first occasion this year on which a south westerly wind at Colombo persisted throughout the night was the 23rd/24th. This distinction was almost, but not quite, achieved on the 8th/9th.

A. J. BAMFORD,
Supdt. Observatory.

MEETING OF THE ESTATES PRODUCTS COMMITTEE
OF THE BOARD OF AGRICULTURE—May 1925.

Mr. T. Petch, B A., B. Sc., who is retiring after twenty years' service from the post of Botanist and Mycologist in the Department of Agriculture, as the central figure.